First Description of the Ford Eagle Manufacturing Process

Engineering News-Record

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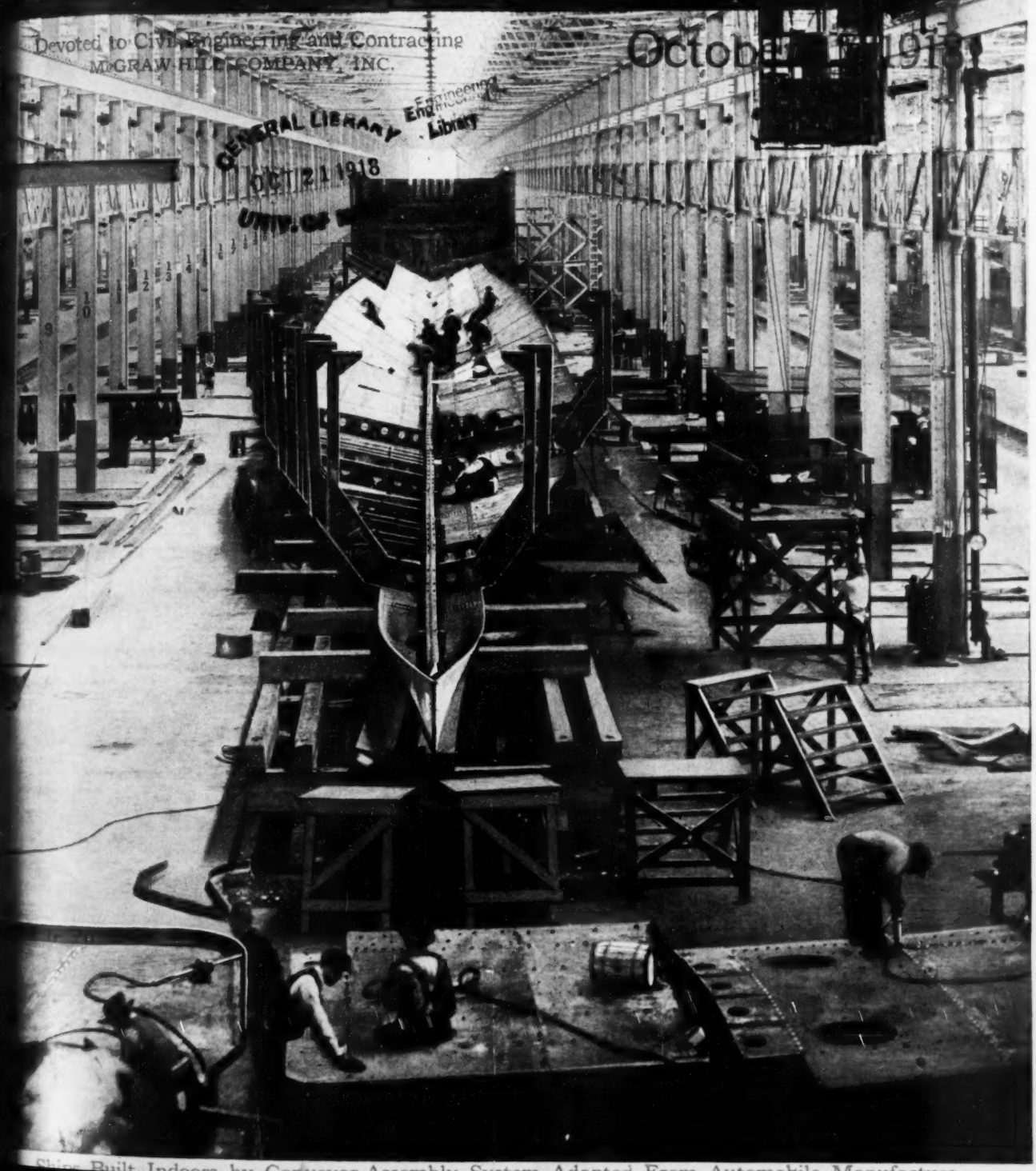

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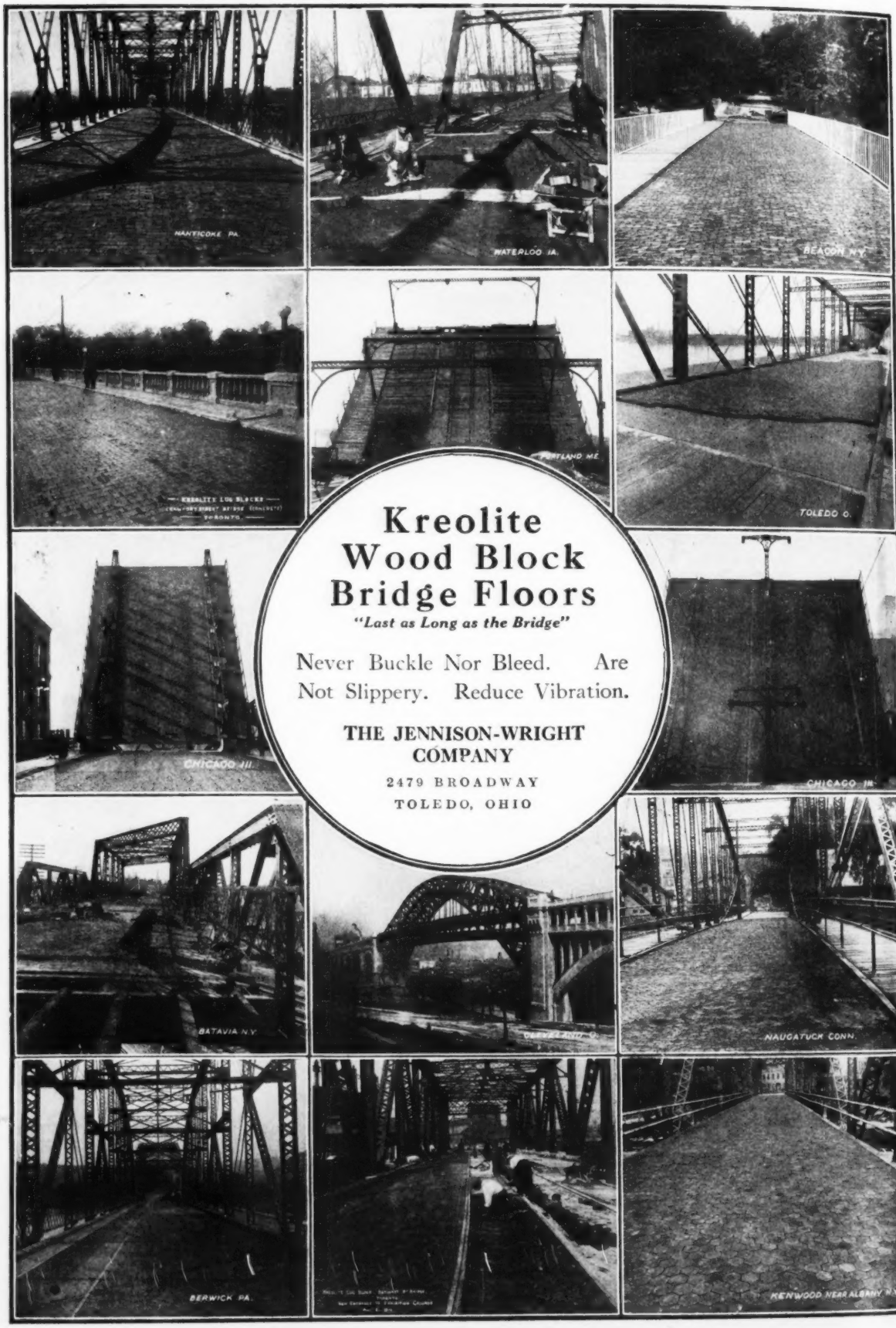

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Volume 81 October 17, 1918 *Number 16*

Engineering News-Record

A CONSOLIDATION OF ENGINEERING NEWS AND ENGINEERING RECORD, WITH WHICH IS INCORPORATED THE CONTRACTOR.

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CHARLES WHITING BAKER, *Consulting Editor*

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ENGINEERING NEWS-RECORD

A WEEKLY JOURNAL
DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. Mehren, *Editor* — Charles Whiting Baker, *Consulting Editor*

Volume 81 — NEW YORK, THURSDAY, OCTOBER 17, 1918 — Number 16

No Relaxation

GERMANY admits defeat. It remains for her to accept terms and give necessary guarantees. Until she does both, our war efforts must be increased not relaxed.

Every Engineer

SOON or late peace will come. We are not prepared for it. Every engineer not in the war should address himself to reconstruction, as suggested in a letter on p. 729, lest peace, however long delayed, find us still unprepared.

All Engineering Societies

UNITER action would accomplish infinitely more for reconstruction than isolated individual effort. It can be secured at once if all our engineering societies will make reconstruction problems their chief concern. Which society will be first?

An Example

A RECONSTRUCTION conference has been called by the National Municipal League. Its program goes far beyond the municipal field. The conference at Rochester (see p. 734) should be largely attended by engineers, public officials and representatives of engineering societies.

Every Municipality

HOW many cities are awake to the fact that they should immediately formulate reconstruction programs? Very few. Adjourning politics indefinitely, every city should address itself to what is fast becoming the most pressing question of the hour.

All States

STATE authorities should act. Reconstruction legislation for both states and cities will be needed. Fortunately most of the legislatures will be in session this winter. No time should be lost in drafting legislative bills, framing budgets and planning state engineering work for the reconstruction period.

The Nation

AT LAST reconstruction legislation is before Congress. The Weeks-Madden resolution provides for a joint Congressional Committee on Reconstruction, composed of 12 members chosen by political caucuses. Far better is the Senator Overman bill creating a Commission on Reconstruction, consisting of five full-time paid members appointed by the President. Engineers and engineering societies should back the principle of the commission bill and secure copies of it for study.

The Railways After the War

THERE are plenty of indications that strong opposition will develop to any attempt to return the railroads after the war to the competitive system. Very likely popular sentiment will force the permanent retention of them by the Government. The alternative of unified corporate control proposed by Mr. Dennis on p. 711 is not a new idea. The advantages of such a plan are well set forth by him, however. This plan, or some less comprehensive scheme of regional corporate operation, seems to offer the best solution of a peace problem which needs early attention, judging from the recent news from Europe and Asia Minor.

Recruits for the Construction Ranks

AFTER the war the ranks of the contractor will be materially strengthened by a group of returned soldiers who as young students are now being trained in the vocational schools of the Committee on Training and Instruction. Already Purdue University has turned out a contingent of 100, and the second unit started in early in September. These men, as noted on page 712, are getting in a short course such things as every concrete construction man must get in the school of hard knocks before he makes any material success. Perhaps the state institutions will find after the war that this is one of the things they must add to their list of short courses, of which those in the agricultural field have proved so popular. At any rate, this is one by-product of the war not to be belittled.

Partners All For Increased Efficiency

SUPPORTED last month by the War Labor Board, and recently made general for its plants by the United States Steel Corporation, the eight-hour day is rapidly becoming universal. Of more importance than the shortening of hours, however, is the recognition of the principle that working conditions are not adjusted to maximum production until they are so arranged as to give the worker a chance to keep himself at the top notch of mental and physical efficiency. Long hours which denied the opportunity for recreation and produced cumulative fatigue are among the first of these working conditions to be improved. The benefit in increasing individual production has been so long demonstrated by experience that it is not surprising to find one of the largest corporations accepting the plan for all its plants. A further benefit in the reduction of labor turnover among these plants may well be looked

for. The individual can stand cumulative fatigue for a length of time dependent on his vitality. Then his system demands relief. If he is a European peasant, and can make the opportunity, he moves to America. If he is employed in a mine or factory here he changes his job. The next step after making it possible for the worker to reach his greatest efficiency is to make it profitable for him to do this by sharing with him the benefits of increased production and enabling him to improve his social condition. Shortening long hours accomplishes both objects. The logical carrying out of such policies in the industries of this country will make capital, management and labor partners for an increased efficiency the results of which will surprise some of America's competitors in world trade.

Developing Technic of Concrete Boat Building

CONCRETE barges have been built intermittently for the past decade, but conditions of use and cost in pre-war days did not encourage the practice, nor were records of the methods of building given much publicity. In consequence there is no developed technic of concrete boat construction either for the river and harbor lighter or the more spectacular ocean-going ship. So far the latter in this country has been represented by one vessel only and the bold builders of that have not seen fit to give the results of their experience to the profession. Barges, on the other hand, are under construction in a dozen or more widely scattered yards, in each of which individual theories and practices of construction are given full sway. Standard methods have yet to be developed. Nothing can more quickly bring about the very desirable standardization of such methods than the publication of descriptions similar to that of the Aberthaw yard on page 704 of this issue. Each yard will profit by some advance of its fellow yard and this new and promising industry will so much the sooner achieve the stability it deserves.

Another Step Forward in Ship Production

SHIP deliveries from the new yards of the Atlantic Coast began last week when the 9600-ton steamer "Liberty" was turned over to the U. S. Shipping Board at Kearny. The event marks another epoch in our shipbuilding history, for it was on the mammoth fabricated-ship yards—Kearny, Newark Bay, Bristol and Hog Island—that our hopes for a great emergency fleet had been chiefly founded. Yet without a single contribution from them, American ship production has broken all records in the world's history month after month since early summer. Henceforth even greater performance will be shown, as the productive power of the big yards makes itself felt. Fully four months ago these yards took a place in shipbuilding, for on May 30 Newark Bay launched the "Agawam," the first agency-yard hull, and two weeks later the "Liberty" went down the ways. Bristol and Hog Island launched their first ships, "Watonwan" and "Quistconck," early in August. A great fleet of vessels has been put into the water since then by the four yards, but fitting-out proved to be slow work, and not a single ship had been added to the record of completed ships until the "Liberty" was delivered. The period of delay is now over, and September's figure of 362,635 dead-weight tons delivered by the yards of the United States, itself an increase of ten per cent. over the August record, is sure to be far surpassed by the deliveries of October and the months to come.

Inland Waterway Development Lags

PERFORMANCE has lagged farther behind promise in inland waterway operations than in any other war reform. A year ago there was every reason to hope that at last under pressure of railway freight congestion the inland waterway would be permitted to show what it could do as a freight carrier. Active opposition melted away. Government aid was promised and given. Enthusiastic reports from the waterway advocates seemed to indicate a return to the old days when rivers and canals were crowded with shipping. This promise has not been fulfilled. Government inland waterway control has indeed been established and a program for future work has been evolved though not published, but in the eight months which have elapsed since the Government commenced to take over certain canals the actual increase in waterway traffic has been practically negligible.

The New York State Barge Canal is the most conspicuous example of this peculiar blight on activity in a time when speeding up beyond previous hopes is so common as hardly to be noticed. Some increase in traffic on the New York canals has taken place, but the increase is ridiculously small. Just at present there is unfortunately an effort to throw the canal back into what to it is familiar ground, the political arena, but the difficulties with the New York Barge Canal are far deeper than those which lie in party control. That the canal does not work to its full capacity is the fault of the people of the State of New York who will not use it. Education along these lines is a tedious task. While barges for anything like the capacity of traffic on the canal are not available, they could be found for intercity freight if such freight were available. The shippers along the canal, however, still stick to their rail routes.

The Mississippi has been another disappointment. Only this week did the first regular barge line service start, and there is no assurance that this so-called regularity will be continued. Here, again, it is not the fault so much of the Government, which expects to lose money on the early operation of its New Orleans-St. Louis barge line, as it is the fault of the towns along the river which have not provided proper terminals and of the shippers in those towns who make no effort to use the river.

It is disappointing to those who hoped that the waterways operators would rouse themselves from their familiar rôle of theoretical promoters and reformers to find that when opportunity has been offered no real progress can be readily made. Underground opposition the waterways have undoubtedly had. Favorable reports recommending certain desirable measures have been lost in the interminable maze of Washington offices. Terminals have been slow in building. Barges are difficult to get. But all of these things are opposi-

tions which the waterways men should have overcome just as so many other men in these days of stress have overcome what seemed to be insurmountable obstacles in the path toward some necessary reform. The waterways men—and we use the term to represent that group so vociferous in advocating development of waterways in the past—should take a lesson from the other engineers and builders of this war.

Shipbuilding by Factory System

THERE are inspiration and instruction for all, but particularly for the shipbuilder, in the history of the remarkable River Rouge plant, where the "Eagle" submarine chasers are being manufactured. In bold originality the enterprise has few parallels; it embodies shipbuilding of a wholly new kind. Yet the service required was of utmost urgency, and no chance of failure could be taken. The final success of the "Eagle" work therefore is in a way a dramatic climax which brings the courageousness of the project into sharp relief and increases its inspiring effect. But quite apart from this, each item of plant and process invites scrupulously careful study because it was worked out with ingenuity and highly expert knowledge to meet the special manufacturing requirements of the case.

Shipyard men will therefore be certain to gain from a study of the River Rouge work. The story of the development of the process told on p. 698 of this issue, and the fuller operating details to be given in a later issue, make primary appeal to yard managers, as suggestions of new possibilities in improving shipbuilding methods with a view to increased efficiency. Though the plant is very different from a shipyard, almost startlingly so, yet the product is a ship that any yard might turn out, and most of the mechanical operations are not far from identical with those of ordinary shipbuilding. But the work is organized in a manner fundamentally different.

Existing shipyards could have dealt with the mechanical part of the task of putting in the water a great fleet of submarine chasers. The problem was controlled, however, by the Navy's imperative demand for high-speed quantity production and by the necessity of utilizing non-shipbuilding labor—the only kind available. This brought to the fore a proposal of radical character, based not on shipbuilding knowledge but on thorough experience in mass manufacture. It was that factory system should be substituted for shipyard system and that a manufacturing plant of a new kind should be equipped for the work, in which material would be localized, operations segregated, and labor specialized to deal with single operations, all in a way unknown to shipyards. This remarkable proposal was adopted by the Navy, and it is today a working success.

Henry Ford's entry into ship manufacture by way of his automobile factory thus has demonstrated that shipyard tradition and precedent are not essential to the production of ships. Already shipbuilding has shown itself animated by a spirit of innovation which produced progress; the past eighteen months have seen remarkable advance in efficiency. But the radically new instance of progressivism afforded by the River Rouge enterprise cannot fail to prove an added stimulus toward new thought and disregard of mere tradition.

Keenest interest attaches to the distinguishing characteristic of the "Eagle" manufacture—the rigid systematization and specialization of labor. Each worker carries out a single set of operations constantly repeated, using material placed close to hand. It is this fact that makes the plant a factory and the process a manufacturing process; not the buildings or the plant arrangement or the novel launching elevator, but the specialist-labor system applied to carefully analyzed and segregated operations. This is the feature of the process that invites most searching study by shipbuilders. The specialist-labor system belongs inherently to quantity production, but today all shipbuilding is quantity production.

Whether the factory methods of the River Rouge plant can be used to advantage by the ordinary yard is worth determining without delay. If expert study shall show that a system of subdivided organization in hull building is practicable in the shipyard, that it would reduce the handling of material, increase labor efficiency, and speed up production by holding the entire chain of operations up to schedule, the value of the system in our present extreme demand for ships will need no further proof, and shipyard methods should be modified accordingly. There need be no concern over the unsuitability of the system for the commercial shipbuilding of normal times. Readjustment of methods can be carried out at leisure when emergency shipbuilding draws near its close.

Rapid Construction Meets Army Needs

RAPID construction, high efficiency of organization and relatively low cost characterize the erection of the immense war-supply structures built during the past 12 or 18 months for the quartermaster division of the U. S. Army. Sudden demand for enormous quantities of all sorts of supplies for our armies in the field and the training camps made necessary the establishment of great warehouses and other buildings for storage and shipping facilities. Some of these are of a temporary character, but most are permanent structures, many of them with notable features of design. Capability for rapid progress under high pressure is a characteristic of American engineers and contractors, and many works attest their resourcefulness in expediting progress. These army structures, however, presented a special problem, due to their number and size, the difficulties of obtaining labor and material, and the necessity for simultaneous construction in various parts of the country.

This was not a case of a single building or of rapid work to meet a contract or commercial requirement. It was a vast national emergency which had to be met and overcome at once and at all hazards. The record-breaking construction work for the army cantonments was mainly on one- and two-story frame buildings. This warehouse work, however, involved large and tall buildings of steel and concrete, sometimes with difficult foundations to be provided.

The speed with which this work was successfully done in the face of many and great difficulties attests the skill and energy of the engineers and contractors to whom it was entrusted.

Great Submarine-Chaser Factory Produces "Eagles" By Indoor Shipbuilding System

Problem of Rapid Production Solved by Special Design and by Quantity Manufacture—Ship Brought to Material and Men—Launching Elevator—Plant Built in Three Months

[This article has been passed by the Chief Censor of the Navy Department]

SHIP manufacturing instead of shipbuilding, carried on under the roof of an enormous factory, is used for producing the "Eagle" submarine chasers at the new Ford plant on the River Rouge, near Detroit. Shipyard methods were largely discarded when the problem of immediately creating a great fleet of the large chasers had to be solved. The plant is now in regular operation, and the remarkable system of ship construction is a practical reality.

Most characteristic of the system is the fact that the shipbuilding berths are moved along to the material and the men, instead of being stationary and having the men go to the berths. That this process of taking the work to the men, used in automobile assembly at the Ford shops, could be made to serve the needs of high-speed ship construction, was the original conviction of Henry Ford when he undertook to build the fleet of chasers for the Government.

Every effort was bent toward obtaining the highest efficiency in applying the process. Direct straight-line movement of material was made a governing consideration when the factory was planned. A remarkable straight-line plant layout is the result. The "Eagle" plant lacks all resemblance to a shipyard. What emphasizes the difference further is the absence of launching of the kind seen in shipyards. The completed hulls are lowered into the water by a huge elevator moved vertically by hydraulic jacks.

A remarkable ship design is an essential feature of the "Eagle" production. Pressed-steel shapes, electric welding and electric rivet heating were called into service. From the design of the hull to the final equipment of the vessels, the whole enterprise is a fabric of original thought. The plant, conceived as a means for most rapid construction of the chasers—as a quantity-production ship factory—represents a combination of bridge shop, automobile works and marine fitting-out yard.

By the courtesy of the Navy Department in opening the plant to technical inspection, and in supplying data concerning the work, *Engineering News-Record* is enabled to present a description of the perfected manufacturing process. Though this process is in every sense a special solution of a special problem, yet, being the product of technical genius, expert knowledge and manufacturing resource of a high order, it possesses a character that is likely to exert lasting influence on the entire art of shipbuilding.

Realizing the magnitude of the problem before it, the Navy Department brought together a remarkable combination of men to work out a solution. Washington contributed Admiral D. W. Taylor and Capt. Robert

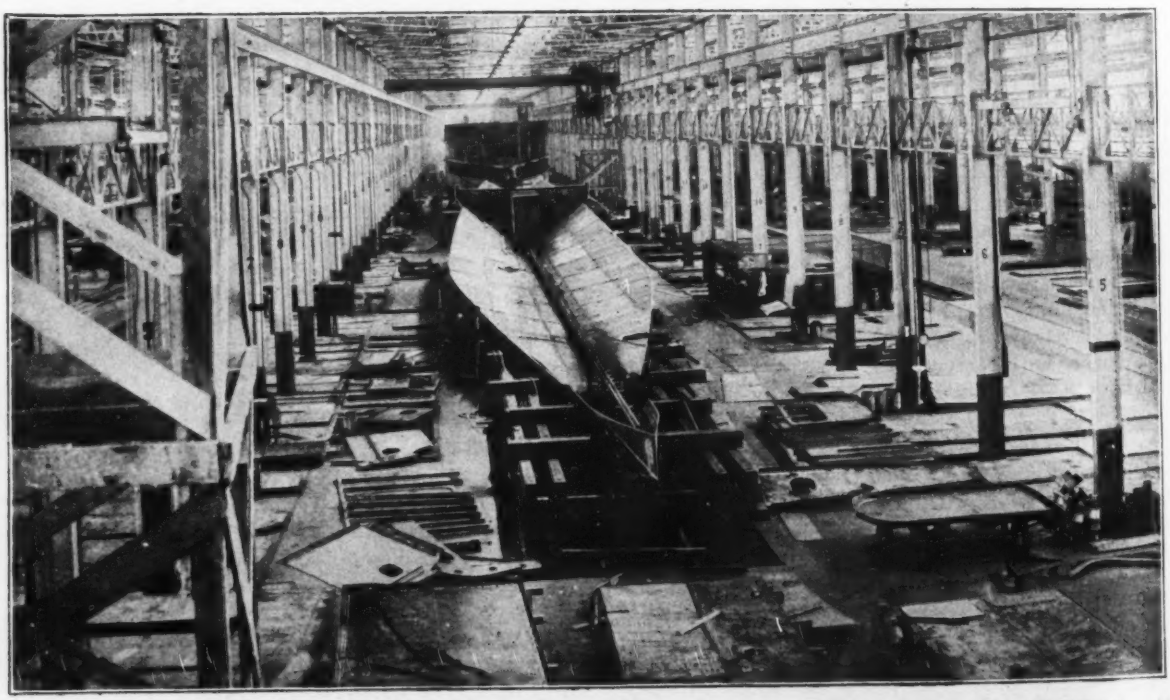


FIG. 1. BUILDING "EAGLES" BEGINS AT THE HEAD OF THE ASSEMBLY SHOP AND CONTINUES AT SEVEN SUCCESSIVE STATIONS; KEEL, BOTTOM PLATING AND BULKHEADS ARE BEING ERECTED AT STATION 1

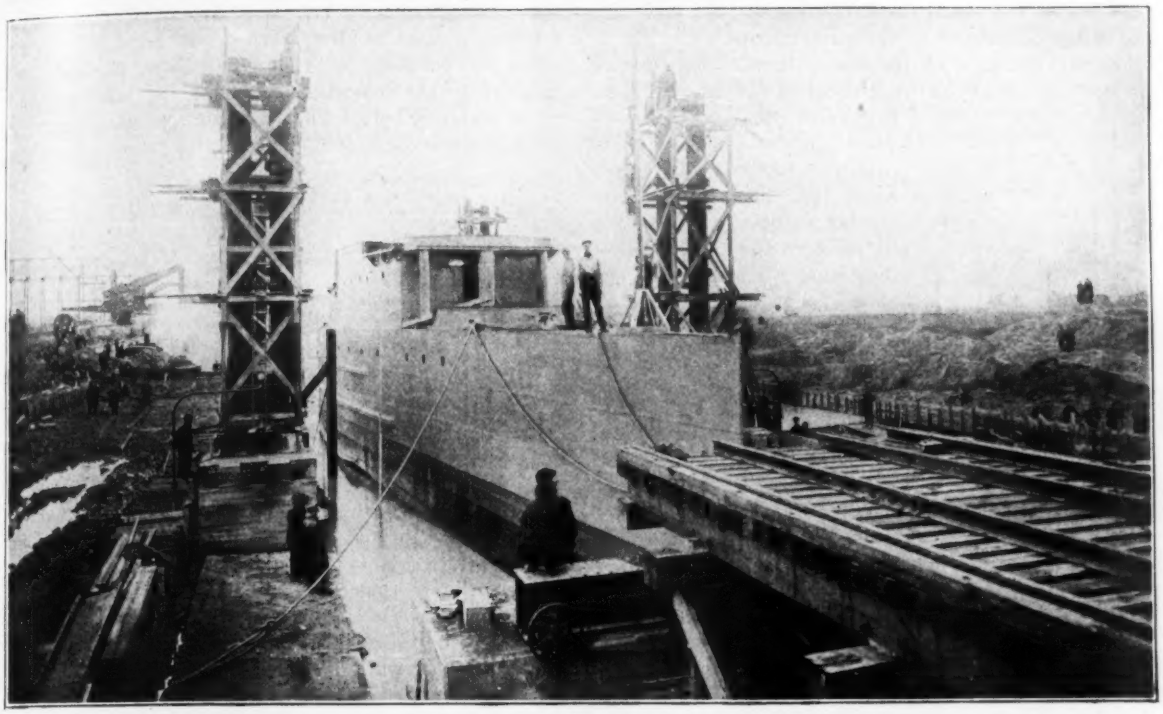


FIG. 2. EARLY IN JULY THE FIRST "EAGLE" WAS PUT INTO THE WATER—A VERTICALLY-MOVING ELEVATOR TAKES THE PLACE OF ORDINARY LAUNCHING WAYS

Stocker, who designed the hull, and Admirals Griffin and Dyson and Commander S. M. Robinson, who designed the power plant. Secretary of the Navy Josephus Daniels contracted with the Ford Motor Co. to build the boats, and thereby brought into the work Henry Ford, systematizer of automobile manufacture, with his strong organization. Shipbuilding experience and craftsmanship were called in by drafting from the Manitowoc Shipbuilding Co. one of the most energetic shipbuilders on the Great Lakes, Charles C. West, to supervise the development of the hull manufacturing system. Commander Carlos Bean, of the Navy, was named to take charge as executive officer and to direct the practical development of the power plant, contributing executive ability and extensive torpedoboat experience.

Through the planning ability and driving power of these men, aided by many others, the results were achieved of converting a paper design into a successful factory-made ship, and a prairie into an operative manufacturing plant, within the short space of three months. Only a little later than this, a working organization was in service, despite the difficulty of obtaining skilled men.

In February the plans for the "Eagle" factory were started; late in May the first hull work was got under way. In July and August the first three "Eagles" were put into the water. Now the plant is in running order, has a working force of nearly three-fourths the ultimate intended strength, and each day is approaching the maximum rate of production.

Ten Elements of the "Eagle" System

In its completed form, as it now exists, the "Eagle" manufacturing system comprises the following elements: (1) A factory design of ship, prepared in its entirety by the Navy Department, a design which has straight lines substituted for curves as far as possible, in longitudinal lines as well as in cross-section (Fig. 3), and with the utmost simplicity and strength of structure; (2) multiple punching applied as extensively as possible; (3) preassembly or subassembly of parts that can be set in place as units; (4) erection of the ships in a long file moving forward to the material and to the workmen; (5) lateral short-distance movement of the hull materials from the storage piles to the ships; (6) step-by-step movement, the file advancing one station (the length of one hull) at fixed intervals (three to six days); (7) arrangement of the work in three parallel competitive working lines; (8) railway-truck mounting of the hulls during erection; (9) transfer of the completed hulls into the water by a hydraulic elevator; (10) installation of interior fittings, machinery and other parts in step-by-step progressive movement of the ships along the fitting-out dock, by a series of stations like those of the hull erection, and with short-distance lateral movement of the material.

The two parts of the system—hull assembly and fitting-out—together constitute a straight-line progressive shipbuilding mechanism, but are physically separated by the launching platform at the center of the plant. A straight-line plant arrangement serves for carrying out the straight-line process.

It does not appear that any one of these elements is vital to the success of the fundamental task of building the ships rapidly. However, taken together they today constitute an integral mechanism—the "Eagle" production system—and they are so interrelated that each one is essential to the successful working of that mechanism. This mechanism grew together gradually during the

evolution of the enterprise; its elements did not come into being as parts of one original conception.

The ship design itself underwent some change during the working out of the manufacturing procedure. Thus, originally the side frames were 6-in. heavy-flanged channels, but when it was recognized that these might give trouble in beveling (required in the stern and bow sections) they were changed to flanged plates, following the design already adopted for the floors and brackets (Fig. 3). Furthermore, the straking was changed so as to make as many as possible of the side and bottom plates parallel-sided and rectangular, to permit of the greatest possible extent of multiple punching (Fig. 4). Some other changes of minor character were made in the design. The important development and change, however,

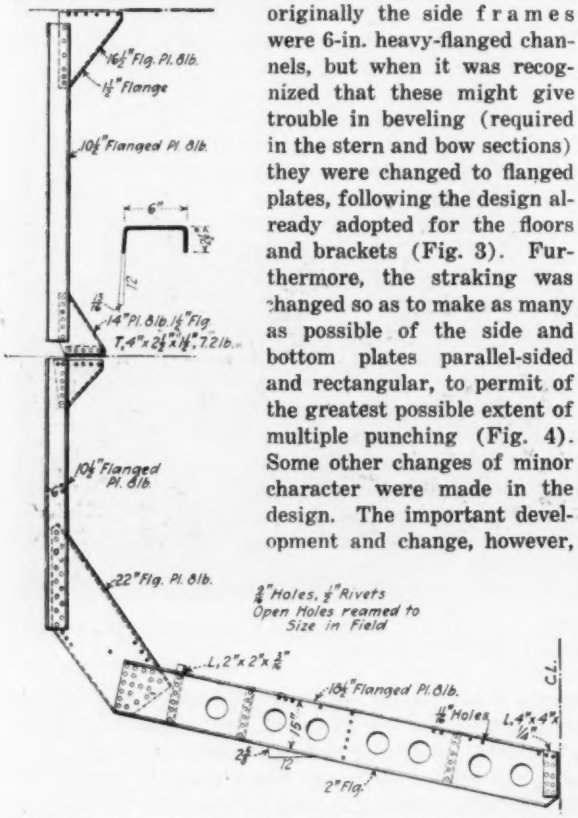


FIG. 3. FRAME OF FLANGED-PLATE MEMBERS IN STRAIGHT SECTIONS

were in the manufacturing system. Essential help in working out both the system and the design was obtained through the construction of a pattern ship in the Ford automobile works (Fig. 5), even before the ship plant had begun to take shape.

How the System Developed

Taking the work to the material and men, the idea of the Ford automobile assembling system, was at first intended to be applied by a conveyor-like arrangement, the ship moving along continuously at very slow speed. Though the company was not experienced in shipbuilding, its successful development of automobile manufacture produced the conviction that the "Eagles" should be built under a roof and that the conveyor-assembly method was practicable and would result in great gain in time, cost and quality. In view of the novelty of its undertaking, the company did not call upon either naval architects or shipbuilders to plan the factory operations. Getting the new enterprise started was, under these circumstances, like building a machine of a wholly new kind and making it an operating success—which, incidentally, describes accurately the task of developing the turbine power-plant with which the ship is equipped.

Time for leisurely and careful development of plans was lacking, under the urgent rush for earliest possible production. Prompt decisions and quick action were absolutely essential. The development, therefore, was a trying process to all concerned, and some steps were taken that conflicted with later decisions. For example, in order to get construction started the buildings had to be designed before all phases of the manufacturing process were elaborated, and it was found afterward

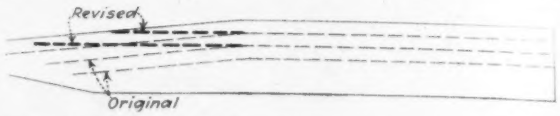


FIG. 4. STRAKING TO INCREASE AMOUNT OF MULTIPLE PUNCHING

that somewhat different arrangements in this or that detail would have been better. That an efficient ship-producing machine was created under these conditions, and made ready for service in phenomenally short time, testifies to the value of the combination of able men concentrated on the work.

In the development of the process, study based on shipbuilding experience early indicated that continuous movement of the file of ships was not practicable, as the individual operations in the hull assembly are necessarily slow and involve large quantities of material. Step-by-step movement took its place, the string of hulls to be shifted forward one ship's length at a time. Seven stations were decided upon; this number was not dic-

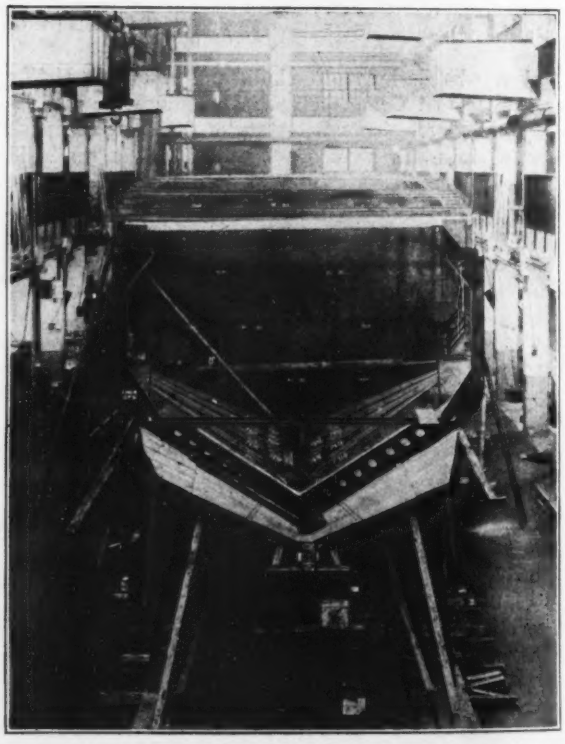


FIG. 5. PATTERN "EAGLE" BUILT IN AUTOMOBILE WORKS TO HELP IN DEVELOPING SHOP DETAILS

tated by inherent requirements of the ship-assembly process, but rather by the anticipated rate of working and the space conditions at the site. The three separate assembly buildings were joined into one, with a material-supply bay between and joining the assembly bays (line bays). Preassembly of parts then came to be recognized

as an important agency of rapid working, and a length of about 200 ft. was added at the incoming end of the assembly shop for doing this work. The progressive or step-by-step method was extended to the fitting-out work, since this half of the manufacture involves as much labor as the hull construction and brings into action even a greater number of trades. Finally, after the shop was already in service, the order of assembly operations was fixed with regard to proper balance of time at the stations, as determined by actual experience in the shop. For fabricating the hull material, single punches were depended upon when the pattern ship was built. Later, machines were considered which would punch a group of holes at a time, the plate then to be shifted ahead by the length of a group. The example of bridge-shop practice prevailed, however, and multiple punching was adopted—using presses having a transverse gang of punches capable of being actuated simultaneously or in sets, and a rack for longitudinal spacing. The equipment plan of the punch shop was revised accordingly, after the building was under construction. Further development occurred later in balancing up the number of multiple punches and of single punches (for doing the work to which multiple punches were not adapted).

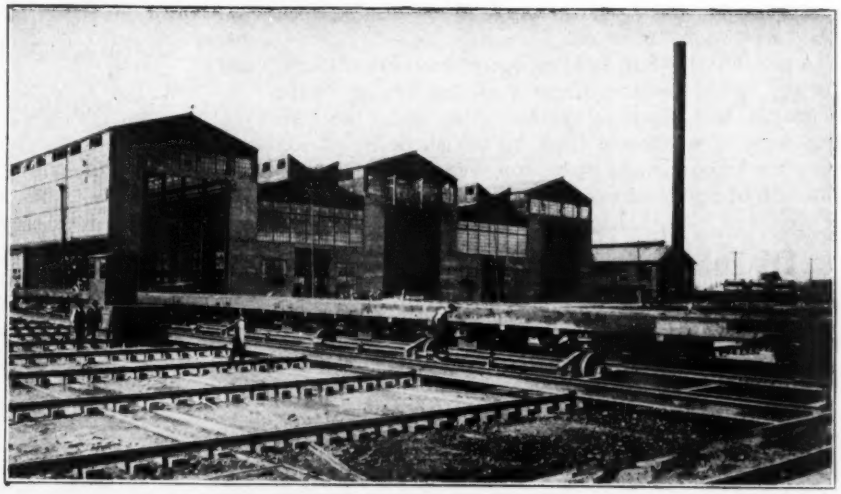


FIG. 7. AT THE MIDDLE OF THE EAGLE PLANT—GREAT TRANSFER TABLE RECEIVES THE ASSEMBLED HULL, PASSING OUT THROUGH ONE OF THE THREE STEEL ROLLING DOORS, AND DELIVERS IT TO THE LAUNCHING PLATFORM

An important contributory factor in the success of the plant development lay in the large resources of the Ford Motor Co. in machines and factory equipment. Thus, the whole shop-crane installation of the River Rouge factory was brought together from Ford assembling plants all over the country, and the multiple punches which form the backbone of the fabricating end of the plant were fitted up from presses taken out of the sheet-metal department of the Highland Park automobile works.

Straight-Line Plant and Straight-Line Process

Lying along the left bank of the widened and canalized River Rouge, some miles from Detroit, the plant extends in a straight line down stream (See Fig. 6). Starting at the north end, its successive parts are the plate-storage yard, the punch shop and, across a transverse road, the huge assembly shop which constitutes the main feature of the plant; just beyond this shop and a short distance to the right is the launching platform to which the hulls are moved by a transfer table (Fig. 7). A few hundred feet downstream begins the concrete dock and ore storage space of the Ford blast-furnace plant. On this dock has been erected a long, narrow fitting-out shed, in two sections, each about 1000 ft. long, which hold the machinery and equipment for the finished hulls lying alongside the dock and moving forward in successive steps to receive different parts of the equipment. Supply warehouses nearby feed the fitting-out sheds.

Direct forward movement of material, in the least number of separate moves, characterizes the plant. From the storage yard, plates and shapes are moved into the punch shop partly by hand and partly by locomotive crane and cars. After the marking, punching and other fabrication, the material is loaded on short railway trucks moved by hand along one of four longitudinal tracks leading into and along the supply bays of the assembly shop. It goes directly to the place where it is to be assembled in the ship, and is unloaded and piled alongside that point. An exception is made in the case of material for preassembled parts, such as frames, deck sections, bulkheads and the like, which is unloaded at the head of the assembly shop and is bolted up and riveted there. The completed parts are then moved down the shop to the proper station by bridge cranes spanning the assembly bays.

Thus, the material and supplies, having once reached the punch shop or the warehouses, undergo in general but a single move to a point directly adjacent to the place of assembly in the ship. From there a short cross-transfer only is required to put them in final position.

Building up a working mechanism for carrying out this revolutionary process of ship construction was done with equal originality and disregard of precedent. Fully as impressive as the boldness of the designers, however, is the great size of the units of the plant. The punch shop in which material is fabricated ready for erection in the hulls is the largest shipyard punch shop in existence. The assembly shop contains 21 shipbuilding berths under one roof (Fig. 1), and in addition a pre-assembly space that in itself is as large as many bridge shops.

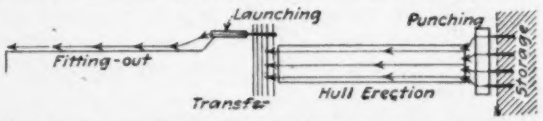


FIG. 6. EAGLE PLANT LAID OUT ALONG A STRAIGHT LINE

The launching platform, conceived by W. B. Mayo, chief engineer of the Ford Motor Co., is the equivalent of a 200-ft. railroad bridge mounted on hydraulic jack supports capable of moving it up and down through a range of 20 ft. Of the same magnitude and difficulty was the task of providing for boiler and turbine manufacture, after the development problems of the power plant had been worked out.

A review of the hull-building operations of the "Eagle" factory, with sketches of some of the special devices employed, will follow in another issue. How the plant was built in so short a time, by concentration of construction resources and by careful organization of methods, will be told by the contractor and the steel erectors.

Discusses Prevention of Cracks in Hard Pavements

William C. Perkins Suggests Hollow-Tile Course to Reduce Heat Conductivity of Slab and Facilitate Drainage

ELIMINATION of longitudinal and other cracks produced by frost heaving in hard-surfaced pavements was discussed in a paper by William C. Perkins, chief engineer of the Dunn Wire-Cut Lug Brick Co., read before the recent meeting of the American Society for Municipal Improvements, at Buffalo, N. Y. Mr. Perkins suggested the use of a hollow-tile bottom course, which he believes would give sufficient insulation between the subgrade and the atmosphere to prevent serious freezing and consequent heaving. The course would also give immediate drainage for all water collecting under the slab, and at the same time give a foundation nearly if not quite equal in strength to the same depth of concrete. The following is an abstract of his paper:

Many brick and concrete pavements, especially in Northern latitudes, develop unsightly cracks along the center line of the pavement, which mar the otherwise satisfactory surface. These cracks may not lessen the durability of the pavement, and they are easily taken care of at small expense; but they are defects which we should endeavor to overcome by improved construction methods.

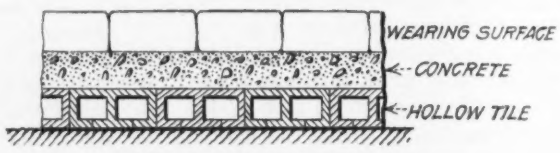
Study of longitudinal cracks in hard-surfaced pavements has evolved several theories of the cause. The generally accepted cause is the pressure exerted against the under side of the artificial foundation by the freezing of water in the underlying subgrade. Undoubtedly other conditions, such as traffic or soft subgrade, may be a contributory cause of cracking; but in the writer's opinion, 90% of longitudinal cracks are the result of frost heaving.

How can this frost action be prevented? We have said in the past, "Drain! Keep the subgrade dry." We have done so, and though many different forms of drainage have been used, we still have longitudinal cracks, many times directly over our elaborate system of drainage. Underdrainage is unquestionably advantageous in lowering the water table, but present methods fail to keep subgrades dry, particularly in clay soils and in soils susceptible to capillarity. While our present drainage system does not prevent cracks due to frost, it does tend to prolong the life of pavements. Nevertheless, in spite of drains, a certain amount of water reaches the earth underlying and supporting the artificial foundation, and successive freezing and thawing, especially in the early spring of the year, cause upheaval of the subgrade. As the pressure cannot go downward on account of the frozen ground, it must extend upward. This upward thrust breaks the pavement.

We do not know exactly how the pressure acts; we have not enough data on the subject to warrant positive conclusions. Undoubtedly, after the war, when engineers will have more time for research work, tests will be made to determine exactly how the resultant forces are distributed through the pavement. All we really know now is the result.

Evidently, the remedy must be found in a foundation design. Can we construct a foundation which will, either entirely or in some measure, overcome the destructive action of frost? As a means for accomplishing this purpose, the foundation design of which a drawing is shown in the illustration is suggested for consideration.

Upon the prepared subgrade lay a course of two-duct tile 4 in. in height, outside measurement. The surface measurements could be any standard size, but the



HOLLOW TILE SUBFOUNDATION INSULATES AND DRAINS SUBGRADE

writer would suggest 8½ in. wide by 12 in. long. The tile may be made of any desired material, such as concrete, vitrified shale or clay, and of any shape or form. Complete this foundation with 2 in. or 4 in. of concrete or other suitable material. We have then prepared a 6- to 8-in. foundation upon which to place our wearing surface of any standard material that is used for paving.

By the use of the tile in the artificial foundation we endeavor to minimize the force of the upward pressure of a frozen subgrade and assert that its use will produce results as follows:

1. The tile will act as a nonconductor of heat between the ground and the surface of the paving. The air within the ducts of the tile, serving as a nonconductor prevents the frost from penetrating through the pavement to the subgrade, or, in more technical language, prevents the escape of heat from the earth. In many sections this type of construction may prevent actual freezing of the subgrade, while in extreme Northern sections it will materially reduce such freezing of the subgrade.

2. When the earth, or subgrade, does freeze, notwithstanding the heat insulation of the tile, we believe that the upward pressure of the frozen subgrade will be dissipated by the eventual breaking of the tile, and that the force or explosion will be compensated for by the air space and not be transmitted to the paving above. Should the tile be too strong to break under pressure

of a frozen subgrade, the bottom of the tile, under the air spaces, could be "scored," thus providing a weak spot to break under this upward pressure. The super foundation and the wearing surface will be sufficiently strong to bridge over any breakage of the bottom of the individual tile under the air-space sections, since the walls and partitions of the tile will remain intact and afford ample support to the super-foundation.

3. The tile, not having the joints cemented, will also act as drains to carry off any ground water or water drawn into them by capillary action, thus lessening the hazard of cracking due to the upward force exerted by frost in the subgrade. They may be laid longitudinally, transversely or diagonally. If they are laid either transversely or diagonally the water will be carried to the curb or edge, where it can be taken care of by means of longitudinal drains or French drains of gravel or stone. If the tile are laid longitudinally the water can be taken care of at regular intervals by cross drains of tile or by French drains of gravel or stone. The grade and cross-section of the improvement will determine these details.

It is difficult to estimate comparative prices in these abnormal times, but, basing estimates on available data, the 4-in. tile should not cost more than 4 in. of concrete in place, and if constructed as suggested the tile and concrete foundation should be able to carry at least the same load as if the foundation were constructed entirely of concrete or of a material of equal load-bearing strength.

The type of foundation suggested as a means of preventing longitudinal cracking of hard-surfaced pavements is the result of study and experience, and while it has not been subjected to the final test of practical service under all kinds of climatic and traffic conditions, the writer has sufficient faith in its utility for the purpose designed to have the type of construction protected by patent.

Interpolation of Contours

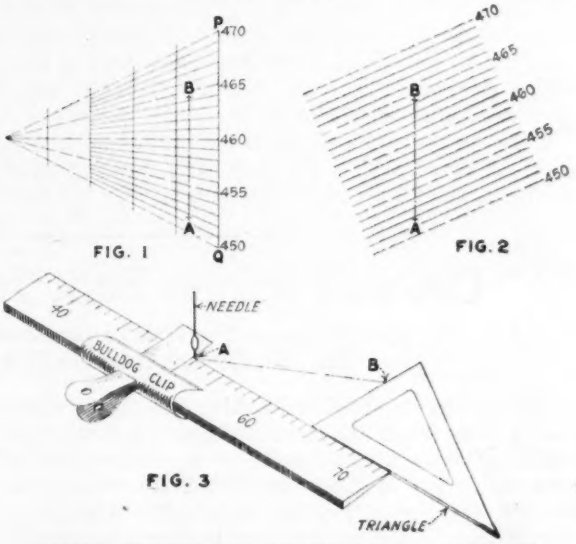
Use of Triangle Sliding Along Scale Found Easier Than Pricking of Points Through Ruled Tracing Cloth

BY IAN M. SUTHERLAND
Novar, Dandenong, Victoria, Australia

There are many ways of interpolating contours, and perhaps no new one has been devised in a decade. But time can be wasted by a clumsy method, and textbooks dismiss the subject so briefly that an occasional review of it in this journal seems in order.—Editor.

CONTOUR lines between two points A and B whose elevations are known can be interpolated in so many simple ways that most textbooks of surveying do not mention them, but when many contours have to be plotted the choice of a method is worth consideration. The writer has found the use of a scale and triangle most satisfactory.

In a method described by J. Whitelaw, Jr., in his book on surveying, a diagram similar to Fig. 1 is made on tracing cloth. Suppose, for example, that the elevation of A is 451.65 and that of B is 464.31. Take the lowest dotted line to represent the 450 contour, the next dotted line 455 and so on, and place the tracing on the plan so that the point A is covered by a point on the tracing that represents El. 451.65, and B by a point that represents El. 464.31. The tracing must be so placed that the line PQ on the tracing is parallel to the line AB on the



THREE DEVICES FOR INTERPOLATING CONTOURS

plan. When the tracing is in the right position the contours can be marked where they cut the line AB by pricking through the lines on the tracing.

The writer must admit that he has found the three simultaneous adjustments of the tracing on the plan so difficult that he has never used this method.

A better method was described in some periodical within the past ten years. A diagram similar to Fig. 2 is made on tracing cloth. As before, suppose that the elevations of the points A and B on the plan are 451.65 and 464.31. Take the lowest dotted line as El. 450, the next dotted line 455 and so on, and with a pricker mark a point on the tracing to represent El. 451.65, set this point over A on the plan, and drive the pricker slightly into the plan. Then swing the tracing cloth round on the pricker through A as a pivot until the point B is covered by a point on the tracing to represent El. 464.31, and prick the intersections of the contours with the line AB through the tracing as before.

The advantage of this method over the first is that only two adjustments of the tracing are required instead of three, and that when one has been made it is not disturbed while the other adjustment is being made. Of course, for a small-scale plan consecutive lines on the tracing can be taken to represent 5-ft. instead of 1-ft. contours, and it is a convenience to have one or two tracings with different spacings of lines so that the intersections of the tracing lines with AB will not be too oblique.

The writer used this method for some years and found it satisfactory until the job of plotting contours between a few thousand tacheometer levels written in very small pencil figures on a small-scale plan was given to him. There it was almost impossible to read the

figures through the tracing cloth. After several trials a method requiring the following instruments was adopted: (1) Ordinary draftsman's scales; (2) a strip of thin sheet metal (aluminum does well) cut to convenient shape, bent round a scale so that one edge can be set to any reading on the scale, and clamped in place with a small bulldog spring clip (the metal should project about ½ in. beyond the edge of the scale; a piece of paper pasted inside the strip of metal prevents it from staining the scale); (3) a few fine sewing needles, each with a drop of sealing wax about ½ in. from the point to serve as a handle; (4) a small celluloid triangle.

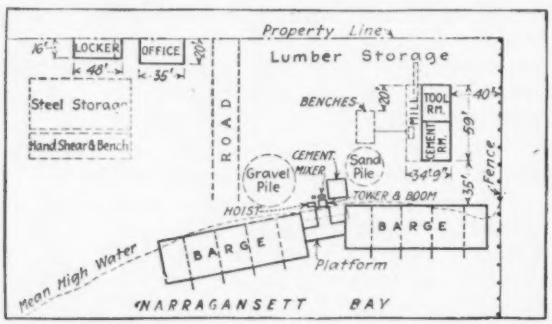
The drawing shows clearly how the interpolating is done. A needle against the scale holds the position of one point, the triangle with the base against the scale passes through the other point and the location of the contour points is found by sliding the triangle along the scale.

This last method is less trying to the eyes than the two preceding ones, because the figures and points on the plan can be seen directly instead of through tracing cloth, which is soon made opaque by handling. There is less chance of large errors, because a properly figured scale is used instead of a tracing that is usually without figures; and, finally, the method is more convenient because the most suitable one out of a number of scales can be used instead of a specially ruled tracing that will sometimes give intersections too oblique for accuracy unless a number of tracings of different scales are available.

Concrete Barges Built True to Design Dimensions

Special Spacers Fix Wall Thickness and Rod Location—Boston Construction Firm Starts New Concrete Shipyard at Providence, Rhode Island

CARE in placing steel and making and placing forms so as to insure the structure exactly following the design dimensions, is a feature of the construction of concrete barges in the yard of the Aberthaw Construction Co., Boston, at Fields Points, Providence, R. I. The accuracy of this work is considerably in advance of previous practice in ordinary concrete operations. At present only lighters designed by the company are being built at the yard, but ship construction is anticipated, and the yard layout is designed for the economical conduct of such work.



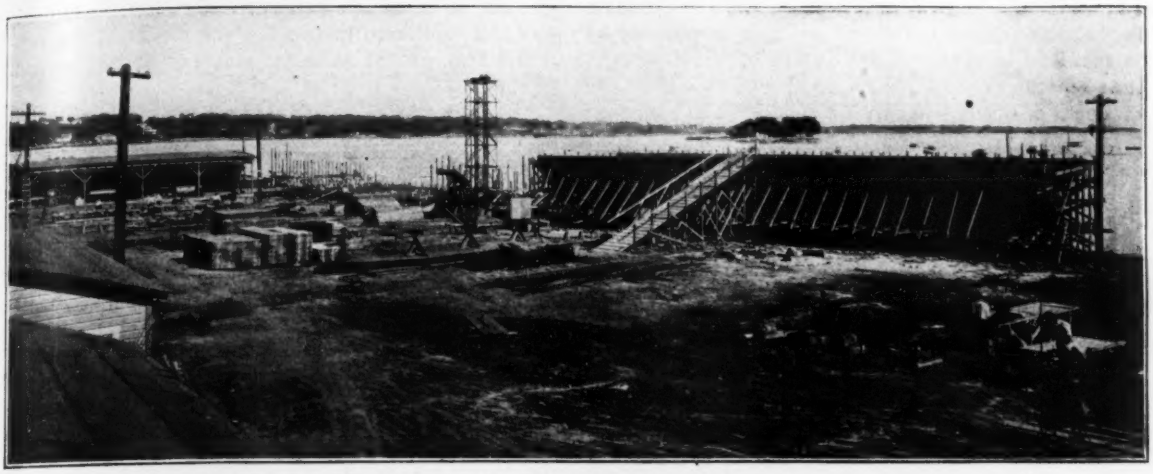
YARD AT PROVIDENCE, R. I., WHERE CONCRETE BARGES ARE BEING BUILT

The barges which are being built are 112 ft. over all, have 34-ft. beam and are 11½ ft. deep. Their details are given in an accompanying drawing. The draft empty is 3 ft. 9 in., and loaded 9 ft. Four transverse and two longitudinal bulkheads extend from the bottom of the boat to the deck, subdividing it into 15 water-tight compartments of approximately equal cubical capacity. The frames are spaced 4 ft. on centers transversely, the junctions of the frames, bulkheads, etc., being made with proper angle fillets or haunches. The deck is without camber, and a timber bulkhead, with sidewalls 2 ft. high and end wall 5 ft. high, incloses an area 90 x 30 ft., provided to assist in holding the deck load. The compartments themselves are adapted for carrying fuel oil. On spacings of 3 ft. 9 in. transversely, stiffeners 5 in. wide and 5½ in. deep extend out from the longitudinal bulkheads. Similar stiffeners spaced in line with the frames, that is, 4 ft. c. to c., brace the transverse bulkhead. The deck is 4 in. thick and the bottom and sides are 3 in. thick, both being reinforced with transverse and longitudinal rods as shown in the drawings. The minimum spacing of the outside of these rods from the surface is 1 in. A similar distribution of steel is in the 3-in. bulkheads.

The new yard is on Narraganset Bay where, by dredging, 4 ft. depth at low water has been provided alongside the two building ways from which the barges will be side launched. Shops for the construction of the forms and fabrication of the steel form the building equipment, and the concreting plant is a mixer and hoist located between each two barges, as shown on the drawing of the yard.

As shown in one of the views, the building ways are, in effect, the framework on which the forms are set. That is, the lagging which is the bottom form of the barge rests on joists and girts spanning the tops of posts which in their turn foot on sills 8 to 12 in. wide by 6 in. thick, laid in trenches of a sufficient depth to provide a bearing value of four tons per square foot. Throughout this framework a variation from level of more than ¼ in. is not allowed.

In the construction of the building ways and the forms the sills, posts and girts are first erected true and level, the sills being firmly tamped into place. Joists are then carefully spaced, and lagging for the floor is laid in place. The outside wall panels are then erected and braced so that they will maintain a position exactly corresponding to the outline intended for the boat, and bolts, wooden washers and cast-iron spacers are located in positions ready to receive the reinforcing steel. After the reinforcement has been placed in the floor and sides, concrete blocks, shown in one view and drawing, for supporting the inside forms, are placed and floor forms are erected. The inside forms for walls and the forms for bulkhead walls and stiffeners are next put up, care being taken that the inside panels on every wall stop at the horizontal construction joint indicated by the end of the first day's concreting, which



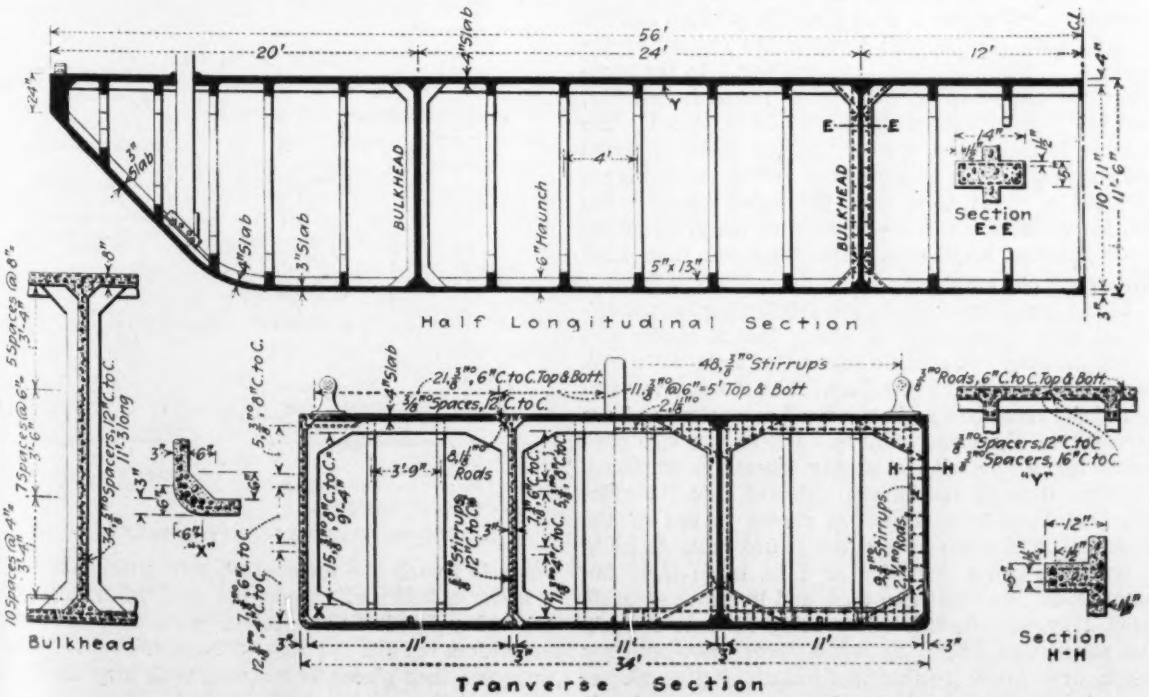
CONCRETE BARGE ON SIDE-LAUNCHING WAYS AT PROVIDENCE SHIPYARD

as a rule is about 3 ft. in lift. Forms for the posts, deck beams and sufficient deck joist to act as deck staging are then erected and braced rigidly in position. The joist are used to support the runway for buggies or wheelbarrows used in distributing the concrete. When concreting has proceeded up to the construction joint and has set properly, the inside forms are completed and the deck panels placed ready to receive reinforcement and concrete.

The forms themselves are in panels and in two types, one for the outside and one for the inside. On the outside every precaution is taken to insure a smooth, impervious surface; on the inside absolute smoothness is not so important. The forms are of sound, good quality spruce, extra cleating being used to prevent warping and twisting as far as possible. Panels are all surfaced with a coating of 26-gage galvanized iron, the sheets being applied butt-jointed and tacked in position, the metal stopping exactly at the edges of the panels. All exposed woodwork on the forms is painted with one cast of boiled linseed oil as soon as the panels are framed, in order to make them as impervious to weather conditions as possible.

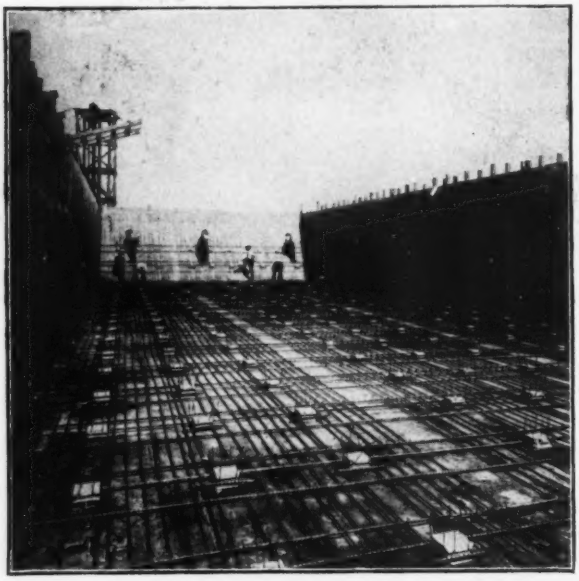
The greatest care is taken that the outline of the barge is maintained in the plan, that the outside forms are smooth and as nearly perfect as possible, that all joints on the outside forms are filled with putty before concreting, and that the wall thicknesses, beam and stiffener sizes and floor deck thicknesses conform exactly to the specifications. All wall panels remain in place not less than one week after the concrete is poured; floor and deck panels require two weeks.

Proper thickness of walls and location of steel are insured by special separators designed for this purpose.



500-TON CONCRETE LIGHTERS BEING BUILT BY ABERTHAW CONSTRUCTION COMPANY

In the side walls and bulkheads, which are 3 in. through, the tie-bolts holding the forms are held in position by the cast-iron separator shown in one of the drawings. These separators are threaded, as shown, on either side to a depth of about ½ in., with a solid steel lift between



INTERIOR OF BARGE BEFORE CONCRETING. NOTE CONCRETE FOOT BLOCKS FOR DECK FORM POSTS

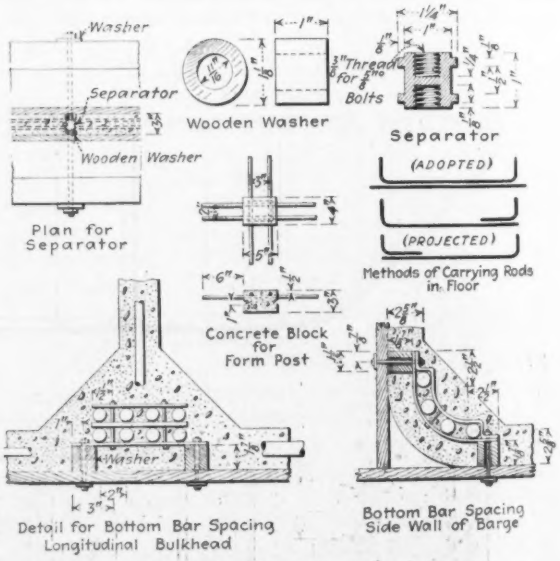
the threaded portions so that there is no possibility of the tie-bolts working through or of the concrete seeping through the separator. On either side of the separator is a round wooden washer. In the erection, the outside tie-bolt is fastened to the outside forms, the wooden washer slipped over the bolt and the cast-iron separator screwed on. The steel is then placed in position and the upright bars are fastened between the flanges of the separator. These upright bars are wired to the separator, the remainder of the steel is placed in position, and the wooden washer on the inside is placed. The outside form is then erected and the inside tie-bolts are screwed home in the separator. When the forms are stripped a slight blow with the chisel removes the wooden washers, which are made with the grain of the wood running lengthwise. The holes are then filled with grout and smoothed off.

In the handling of the larger reinforcing bars a different type of separator is used. This is shown also in the drawing. It consists of a set of stove bolts with plate spacers between the bars. The wooden washers are of the same type as in the small separators and are removed in the same manner. Where the side wall meets the bottom slab a similar scheme is employed. Running through the bottom slab and into the sides are transverse bars shaped as shown in one of the sketches. These bars presented considerable difficulty in bending, and a variation of ¼ in. made them impracticable. To straighten them and to secure accurate bend, they were heated before being bent on the job. An alternative scheme in which there were overlaps which were wired together was found objectionable because it brought so much steel in a narrow space that it was almost impossible to fill the interstices. No difficulty was met elsewhere in bending the steel, and the separators have proved quite acceptable in getting accurate placing.

The concrete is mixed in a four-bag mixer with side loader for charging, and is spouted from a tower hopper, by means of a short section of chute, to a distributing point, or to buggies or wheelbarrows at the end of the boat at deck level. From this point it is wheeled along the staging at deck level, where the placing gang is working, and run through a short chute to a mortar box at the level of the placing gang, where it is shoveled into place in the forms.

Concreting proceeds continuously from the point at which it starts, working constantly around the edges of the material already deposited so that nowhere does any section stand, in wall or floor, for more than one-half hour before new concrete is placed. Where a definite joint is provided, the surface is carefully picked to remove all laitance. It is washed thoroughly clean and painted with a coat of grout, consisting of neat cement and water mixed to the consistency of cream. Concreting proceeds before the grout takes its initial set. While the concreting is being done the forms are constantly tapped with wooden mallets. The outside of the boat is painted with one coat of asphaltic paint.

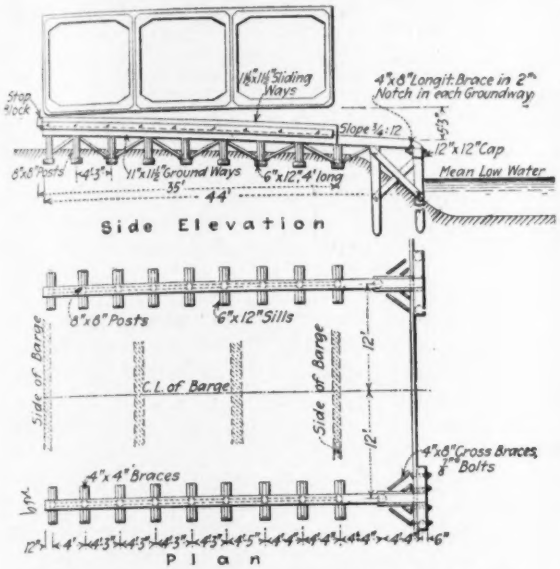
Launching ways for side launching are provided independent of the building ways. Four groundways extend under each of the transverse bulkheads. These are 11½ in. thick by 11 in. deep, of long-leaf yellow pine and are supported on posts on the ground end and on piles over the water. They are set, before the construction of the barge begins, to a slope of ¾ in. to the foot. Sliding ways are made of 11½ x 11½-in. yellow pine, with 4 x 8-in. guides bolted on either side. When



SPECIAL SPACERS HOLD FORMS IN LINE

ready to launch, the form panel, 4 ft. wide, under each transverse bulkhead is removed and the bottom thus exposed painted. The ground ways are thoroughly greased on top and the upper 3 in. of the side. Sliding ways are then placed in position, with stop blocks, as shown, at the upper end.

Building jacks are blocked up on cribs of railway ties on either side of each launching way and longitudinal bulkhead of the barge, making six jacks at each transverse bulkhead. The barge is then jacked up enough to permit the removal of all forms, great care being taken when the jacking is done to obtain as nearly as possible equal distribution of the load on the several



CONCRETE BARGES AT PROVIDENCE YARD ARE LAUNCHED SIDEWISE FROM THESE WAYS

jacks. One man is stationed at each screw and the bars turned a quarter turn at a time in unison, until the barge is clear of the building ways. The remainder of the barge is then painted and when dry lowered by the jacks to the sliding ways which have been placed in the meanwhile. After the barge has been lowered to the sliding ways and is ready to be launched, all four stop blocks are driven out or sawed off.

In the designing of the barges the bottom slab and frames are planned to carry an upward pressure of water equal to a head of 11½ ft., the side walls and frames being designed on the assumption that the water may be flush with the deck. It is intended that the deck frames will take a live load of 500 lb. per square foot uniformly distributed. In the design of bulkheads it is assumed that any compartment may be filled with water. Fiber stresses in the concrete are based on the expectation of using a concrete which will develop 4000 lb. per square inch in 28 days, and the maximum stress of the steel is assumed to be 16,000 lb. per square inch.

The concrete is made up of one part portland cement to one part of sand and two parts of stone. The coarse aggregate is a broken trap rock sizing up to ¾ in. in diameter, and the resulting concrete weighs about 150 lb. per square inch in 28 days, and the maximum stress of water is avoided. Each batch receives not less than 2 min. of actual mixing after all the materials are in the mixer. The stone and a portion of the water are first placed in the mixer, which is turned over sufficiently to scour the stone clean, the aggregate, cement and water being then added. The amount of water to obtain the best result is approximately 9% by weight of the cement and aggregate. Volumetric and weight tests are made to determine maximum density.

Steel is of round bars of mild structural grade. For the longitudinal girders the rods are in one continuous length, obtained where necessary by butt welding two or more bars. Care is taken that the welds are staggered, no two being within 40 in. of each other. Steel bars in the transverse frames are made continuous in like manner. The crossing of each bar with another is wired with soft, annealed, iron wire wrapped around and twisted tight.

System Controls Openings in City Pavements

City Engineer Does Backfilling and Repair Work With the City Forces—Blank Forms Used with Plan Are Reproduced

BY D. B. DAVIS
City Civil Engineer, Richmond, Ind.

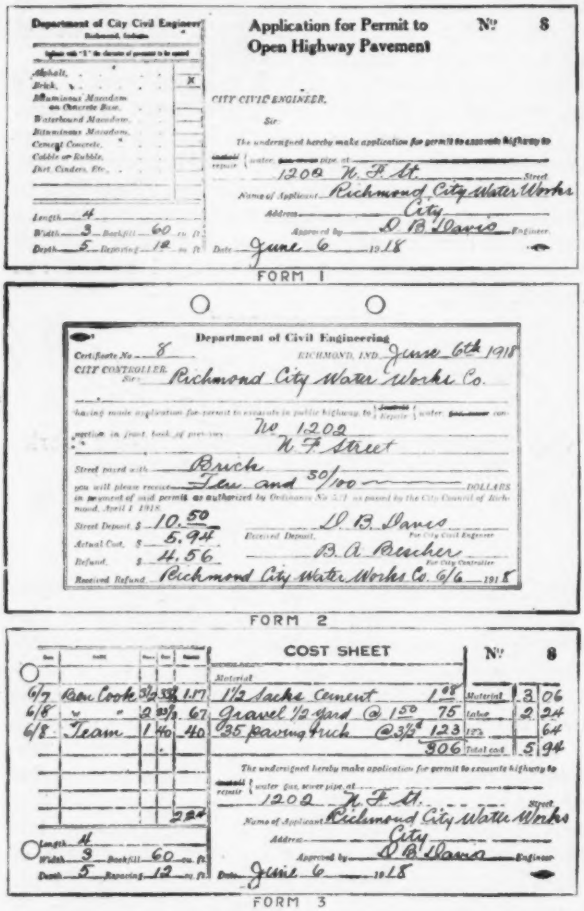
THE proper control of openings in street pavements at Richmond, Ind., is effected by a system of permits deposits and refunds authorized by the city council. The work of backfilling and repaving is taken over by the city and put under control of the city engineer, who does the work by force account, with city employees.

The city council has passed many ordinances, prohibiting the opening of newly paved streets for a period of five years after building. It has also required that gas, water and sewer service pipes be properly laid before permanent pavements are built. Regardless of these precautions, openings are often necessary for one cause or another, and if the erection of a new building depends on obtaining a new service connection, the five-year provision is nullified.

Openings in street pavements being a necessary evil, the engineer should aim to control them so as to guarantee the replacement of the surface in as good condition as it was before opening. Not only must proper care be taken in repaving, but every foot of backfill must be replaced and tamped in such manner that no settlement will occur. A firm foundation is more important in obtaining permanent construction than a smooth surface.

To expect public utility companies and sewer contractors to take proper care in doing this work is useless. It is necessary to eliminate the universal desire on their part to do the least work for the most money. It was our experience that, generally, little heed was paid by service companies to our request for the repair of sunken ditches. While they were getting ready to do so, traffic was bumping its way over the street, and councilmen became eloquent in their criticism of the administration for not compelling those responsible for bad conditions to make the streets at least passable. These considerations induced the writer to draw up an ordinance which was finally passed and which is giving excellent results.

It requires any person, firm or corporation desiring to make any excavation in any paved street first to make application to the city engineer, giving the location, purpose and approximate dimensions of the excava-



Department of City Civil Engineer, Richmond, Indiana

Application for Permit to Open Highway Pavement No. 8

CITY CIVIL ENGINEER,

Sir:

The undersigned hereby make application for permit to excavate highway to repair { water, gas, sewer pipe, at

1202 N. F St. Street

Name of Applicant Richmond City Water Works

Address City

Approved by D B Davis Engineer.

Date June 6 1918

Asphalt, Brick, Bituminous Macadam on Concrete Base, Waterbound Macadam, Bituminous Macadam, Cement Concrete, Cobble or Rubble, Dirt, Cinders, Etc.

Length 4 Width 3 Backfill 60 cu. ft. Depth 5 Repaving 12 sq. ft.

FORM 1

Department of Civil Engineering

Certificate No. 8 RICHMOND, IND. June 6th 1918

CITY CONTROLLER, Sir: Richmond City Water Works Co.

Having made application for permit to excavate in public highway, to { repair } water, gas, sewer connection in front, back of premises No 1202 N F Street

Street paved with Brick

you will please receive Three and 50/100 DOLLARS in payment of said permit as authorized by Ordinance No 5217 as passed by the City Council of Richmond, April 1 1918.

Street Deposit $ 10.50 D B Davis Deposit. For City Civil Engineer

Actual Cost, $ 5.94

Refund, $ 4.56 B A Boucher For City Controller

Received Refund Richmond City Water Works Co. 6/6 1918

FORM 2

COST SHEET No. 8

Date	Name	Hrs.	Rate	Amount	Material
6/7	Ben Cook	3½	33½	1 17	1½ Sacks Cement 1.98 — Material 3 06
6/8	"	2	33½	67	Gravel ½ yard @ 1.50 75 — Labor 2 24
6/8	Team	1	40	40	35 paving brick @ 3½¢ 123 — Tax 64
					306 — Total cost 5 94

The undersigned hereby make application for permit to excavate highway to repair { water, gas, sewer pipe, at

1202 N. F St. Street

Name of Applicant Richmond City Water Works

Address City

Approved by D B Davis Engineer.

Date June 6 1918

Length 11 Width 3 Backfill 60 cu. ft. Depth 5 Repaving 12 sq. ft.

FORM 3

FORMS USED FOR REGULATING STREET TRENCH REPAIRS. ACTUAL SIZE OF FORMS 1 AND 2 IS 4¼ x 9 INCHES; FORM 3 IS 5¼ x 8¼ INCHES

tion. This application is made in duplicate upon a form as reproduced, one copy being given to the applicant and the other being filed. After the application has been made a certificate is filled out, stating the engineer's approximate estimate for backfilling and relaying the pavement. To this 12% is added to cover tool expense and maintenance. The table shows the approximate costs used for estimating, which were incorporated in the ordinance. The applicant pays the controller the amount stated on the certificate and is then entitled to receive the permit. The certificate is also reproduced herein. The applicant may now make such excavation and lay such service pipes as are indicated on the application, but must make no backfill.

After the pipes have been laid or repaired the city engineer is notified by the applicant and the city does the remainder of the work with skilled workmen especially selected for the purpose. They make a thorough inspection of the pipes before covering them. Accurate costs are kept on the "cost sheet" shown with this article. It is a triplicate of the application form, the name of the applicant and location of the excavation being a carbon copy.

The total cost of all the work incidental to backfilling and replacing the surface, plus 12%, is entered on the certificate. The difference between this amount and the original deposit is the "refund" to the applicant. The ordinance states that if the indemnity deposit be insufficient the applicant shall be liable for the deficiency. The table of estimates was purposely made high enough to cover any emergency which might arise.

Although objectors to the ordinance asserted that the cost would be doubled if the city's men did the work, this has not proved to be the case, but a material saving to the applicants has been effected. This result was obtained because the writer went outside the list of regular city pensioners to secure men who were efficient; a habit which city officials must acquire if they expect to execute work at low cost.

TABLE FOR ESTIMATING COST OF REPLACING MATERIAL IN TRENCHES

Backfilling open trenches, per cubic foot	$0 03
Backfilling tunnels, per cubic foot	04
Repaving sheet asphalt, per square foot	1 50
Repaving brick, per square foot	75
Repaving concrete (non-reinforced), per square foot	60
Repaving concrete (reinforced), per square foot	75
Repaving macadam, per square foot	30
Repaving cement sidewalk, per square foot	25
Repaving brick sidewalk, per square foot	20
Repaving gravel sidewalk, per square foot	10
Repaving boulder alley, per square foot	25

The greatest advantage gained by the ordinance was that it places the responsibility for the maintenance of the streets where it belongs, namely, on the city street department, which can now see that its pavements are safeguarded. Naturally, the success of the system, like the success of any other undertaking, depends upon the persons engaged in its direction. We have found that it fulfills a long felt need, and we can recommend it to places which are experiencing troubles similar to ours.

Pavement Gage Measures Surface Irregularities

Study of Specifications for Smoothness Leads to Invention of New Device—Present Requirements too Severe

By W. M. Kinney

Engineer, Promotion Bureau, Universal Portland Cement Company, Chicago

A PAVEMENT gage which will measure accurately the unevenness of pavement surfaces has been developed by the Universal Portland Cement Co. The belief that present paving specifications are unreasonably severe, if not impracticable, led to an investigation of the smoothness of surfaces of higher class, and a gage was originated to do the measuring. The work, as far as it has progressed, indicates as a desirable specification that no variations greater than ¼ in. in 3 ft. nor ⅜ in. in 6 ft. shall be allowed.

Unevenness in pavements interferes with the smooth riding of vehicles and with satisfactory drainage. To avoid these objectionable results, the amount of variation that will be allowed is often stated, but the specification is usually so worded as to be indefinite. The question then arises as to how much variation from the specified contour should be permitted, and what means should be used in checking up the finished surface. The standard specifications of the American Concrete Institute for concrete pavements require that "the finished surface of the pavement shall not vary more

than ½ in. from the specified contour." This requirement is very strict and, if interpreted literally, requires careful levelling to determine whether it has been fulfilled. Other specifications contain a clause stating that "the finished surface shall not vary more than ½ in. in 3 ft. from the specified contour." Usually nothing is said as to how variations shall be measured, and until that is done the requirements are uncertain, because the appearance, size and number of irregularities depend on the method of measurement.

In the "Proceedings" of the American Society of Civil Engineers of December, 1917, a committee on materials for road construction and on standards for their tests and use recommends the following:

"In a newly completed pavement the variations from a straightedge or templet, 8 ft. in length, should not exceed ½ of an inch for asphalt block, bituminous concrete, brick, cement-concrete, sheet asphalt and wood-block pavement."

In this specification the amount of allowable variation and the method of measuring are given, but the practicability and necessity of such a requirement are open to question. On a cement-concrete pavement where a templet is used, it may be possible to obtain so even and true a surface, but only with exceptional care. The difficulty of carrying out the above recommendation on pavements where heavy rollers are used to obtain the final surface should be obvious. Even if it were possible to get such results, it would be neither economical nor of special advantage to attain such a degree of refinement.

In order to obtain definite information as to the evenness of surface usually attained in construction, and to determine what variations are consistent with smooth

RESULTS OBTAINED BY GAGING TWO EASY RIDING PAVEMENTS EACH ONE YEAR OLD

Kind of Pavement	Gage, Length	Number of Variations per Hundred Feet Equal to or Greater Than ½ In.	¼ In.	⅛ In.	1/16 In.
Asphalt,	3	.....	0.33	....	....
Asphalt,	4	.....	0.82	....	....
Asphalt,	5	.....	2.50	....	....
Asphalt,	6	18.00	3.00	1.16	0.33
Total,	..	18.00	6.65	1.16	0.33
Concrete,	3	.....	0.0	....	....
Concrete,	4	.....	0.16	....	....
Concrete,	5	.....	0.33	....	....
Concrete,	6	16.00	1.00	0.16	0.0
Total,	..	16.00	1.49	0.16	0.0

riding and satisfactory drainage, an investigation of pavements in Chicago and its vicinity is being conducted by the engineers of the Universal Portland Cement Co. Thus far much of their attention has been taken up in selecting the best method for measuring the irregularities, and various methods have been tried and found unsatisfactory.

The method of measuring irregularities is of great importance. Equipment that may be used with ease is desirable, and at the same time the apparatus must measure accurately both humps and depressions. The former are particularly important, as it is the humps which cause the jolting. In the investigation mentioned above five methods have been tried—level readings, 6-ft. straight-edges, bronze wire, fish line, and a specially constructed pavement gage. While the level readings gave good results, they were too slow and expensive to adopt as a standard procedure. With both the wire and the fish line methods, a wedge gage was used to determine the size of the irregularities. By stretching the line tight and using intermediate weights, any desired gage length could be obtained. The difficulty with either the wire or fish line is that it is supported at the high points and the contour of the

USING PAVEMENT GAGE TO MEASURE IRREGULARITIES

surface may be such that over appreciable humps the line is supported for the entire gage length. The profile, which shows actual conditions found in levelling, and which was later tested by means of a fish line, illustrates this difficulty. The use of the straight-edge is open to the same objection, and it has the additional disadvantage that only one gage length can be used.

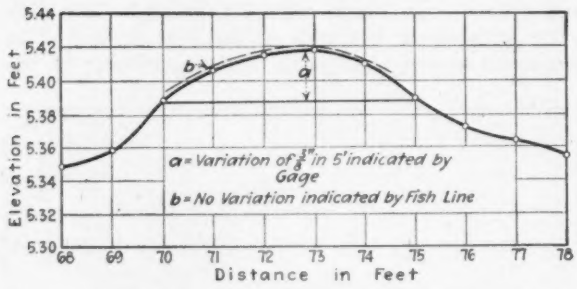
The pavement gage shown in the photograph has been found to measure all irregularities, giving results that check well with the profiles, and with the variations shown by the wire and fish line at depressions. With a 6-ft. gage length the bar deflects approximately 1/32 in. but with the shorter length the deflection is negligible. A graphical record of the total variation is made by a hard compass lead which is held in contact with the indicator diagram paper by a spring. The point is attached to an arm which rests on a roller and which is free to move vertically as it is pushed along the horizontal bar. This gage can be moved continuously along the pavement and will give an accurate and connected profile of the surface.

The table printed with this article records the variations on two pavements, each one year old and considered high class. From these results it will be seen that a variation of ½ in. in 6 ft. is very common, and that an irregularity of this size does not cause unpleasant jolting. It should be remembered that all variations were counted, whether humps or hollows, and that if tests had been made with a straight-edge only the hollows could have been measured accurately. Inasmuch as the pavements recorded were considered excellent, it is apparent that a specification limiting variations to ½ in. in 8 ft. is unnecessarily strict.

Further tests are now under way and will, it is hoped, establish definite conclusions as to desirable allowances for vertical variations in pavement surfaces. A tentative recommendation that no variations greater than ¼ in. in 3 ft. nor ⅜ in. in 6 ft. be allowed, is indicated. In this connection, it may be stated that the variations in the 2-ft. and 4-ft. lengths may be more important than those in the longer gage length,

for it is thought to be the abrupt changes that cause most of the jolting and vibrations.

No great attention has been given to variations of



HUMPS IN PAVEMENT NOT FOUND BY STRING METHOD

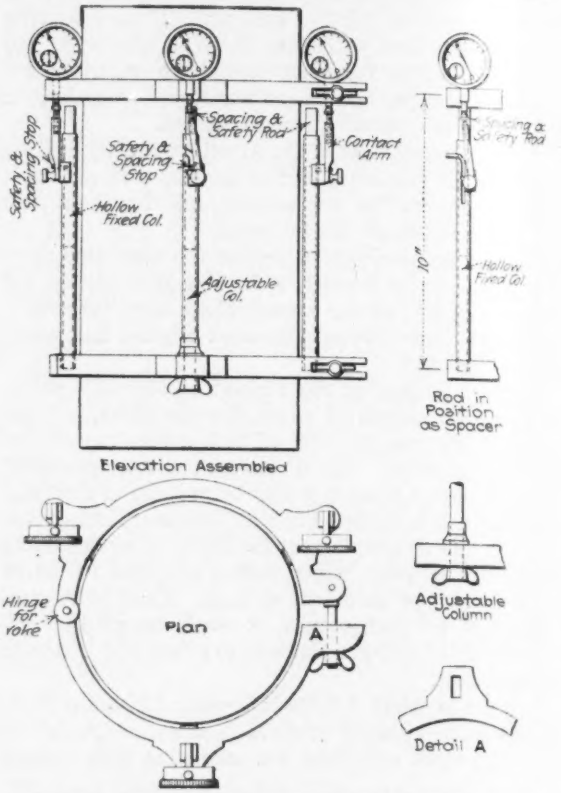
cross-sections. The cross-section is apt to vary more than a longitudinal section, especially if a variable crown is used. However, the irregularities are not so important, since depressions and humps will be found by the test for longitudinal variations. It will probably be found sufficient on the usual low-crown pavement to specify that the section shall be convex upward at every point.

New Compressometer Devised to Measure Elasticity Modulus

By Herbert A. Davis
Assistant Engineer Physicist, Bureau of Standards, Washington, D. C.

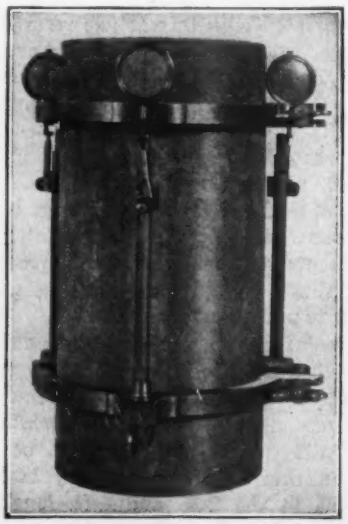
TO DETERMINE the modulus of elasticity of concrete a new compressometer has been developed by the writer at the Bureau of Standards. This instrument is designed for concrete cylinders 8½ in. in diameter by 16 in. high. The deformations are measured over a 10-in. gage length. Three Ames dials reading to 0.0001 in. are used instead of two in order to give a good indication as to the uniformity of travel of the screws of the testing machine in the application of the load.

The instrument is so designed that the yokes can be properly spaced by a part of the instrument itself. To prevent serious damage to the instrument in case of a sudden breakage of the concrete cylinder means were adopted by which the contact arm pressing against the rod of the Ames dial would be removed before the dial



COMPRESSOMETER FOR DETERMINING MODULUS OF ELASTICITY ON CONCRETE SPECIMENS

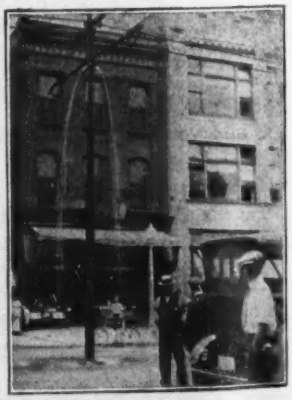
rod had completed its normal travel. To minimize the damage the pin in the yoke clamp was made sufficiently small so that this part would be the first to give way should a sudden break occur.



COMPRESSOMETER IN PLACE ON TEST PIECE

Water-Pipe Leak Makes Novel Fountain

Water spouting from the top of a trolley pole in North Ave., Chicago, was a "freak" leak recently dealt with by the Department of Public Works. This pole, in the middle of the street, was set in a concrete base. It was found that it rested on an old lead service pipe which it eventually cut or broke, the water passing up through the pole until it overflowed at the top. This information and the accompanying view were furnished by R. L. Spalding, engineer of water-pipe extension, who states that while leaks of many kinds have been found, this is the first in which the water has been found coming from overhead.



LEAK UNDER TROLLEY POLE MAKES FOUNTAIN

Unified Corporate Control of the Railways After the War

Would Eliminate the Wastes of Competition Without Risking the Dangers of Permanent Government Operation

By A. C. Dennis
Consulting Engineer, Seattle, Wash.

THE popular belief that a railway can only be operated in the public interest when fighting other lines for its existence may no longer be held if the coöperation of the railways under Federal operation demonstrates the advantages inherent in unified control. It seems not to have been realized in the laws to prevent combination and encourage competition that railways, like nations, cannot exist in a state of war except at the expense of one another and the public. It is hoped that the public, perceiving how wasteful and horrible is war between nations will see that the same laws govern industrial relations as govern political, and that industrial war is wasteful and horrible also. As a combination of petty warring states into a strong nation makes for peace and efficiency, so does a combination of warring railways. To make the railways again war on one another for traffic is a retrograde movement, resulting in wasteful expenditure for unnecessary construction, trains and equipment and in other avoidable expense. Rebates, rate wars and other objectionable practices are the direct effect of fights for competitive traffic.

If Federal management were permanently in the hands of men like the present Director General and his staff there would be little cause to worry over the future of the railways by the public, the employees or the security holders. The general record of the Federal Government as a business organization, however, is not such as to inspire confidence that the railway business administration, after the old system railway men are eliminated, will show a sufficiently great improvement over the Canadian and European government administration to be acceptable to the public. This country would never accept the service and costs of the Intercolonial Ry. of Canada or that of the French or German railways, after having been accustomed to so much better service and rates. European rates, notwithstanding very much cheaper railway wages, if in force on American railways, would be so high as to shut down many industries.

Capable Men at the Head

The operation of all railways under a single corporate management will of necessity put large power and responsibility in the hands of a few men, but this is a necessary step in any successful organization, and not more imprudent on a large scale than we are accustomed to on a small scale. These men will be more likely to be fitted by training and experience to exercise their power wisely to the advantage of the railways and the public than the average management of the past, or those whom the political fortunes of the hour might place in temporary power.

The financing of this gigantic corporation will not appear difficult if based on the present Federal plan of payment of rental to railways on the basis of their average net earnings. The proposed corporation can issue securities to each individual railway company for its physical property in the proportion that the average net earnings of that company bear to the total average net earnings of all railways. The value of a railway or other property is independent of original cost, replacement cost or any other factor except future earning capacity. Past earnings in a railway are an approximately true measure of its relative value as compared with other railways for calculating its proportion of future earning capacity. Each railway company can keep its corporate existence as at present under Federal operation, or use the securities issued to it by the absorbing corporation to liquidate its own outstanding securities.

There need be little uneasiness that a unified corporate control of railways will result in oppressive rates and lack of enterprise in providing facilities for business. The unified control, being free from inter-railway competition, will eliminate much construction and operating waste, which, together with items to be discussed later, will reduce operating costs very materially, thus providing the opportunity, if desired, to reduce rates. Every additional ton handled by a railway, up to the economic traffic capacity, is handled at an increased margin of profit. The desire by the railway management for increased business with the increasing margin of profit with each increase will have the effect of reducing rates to the economic minimum. Every saving in railway operation tends to reduce rates, and every addition to operating costs tends to raise rates or impair service. The incentive to increase business by low rates, and encourage new industries by providing facilities, will be just as strong as when the temptation to steal the traffic from a rival existed. It may quite possibly be found that the rates voluntarily made by the skilled traffic department of a railway, not subject to inter-railway competition, will be on a fairer basis than those made by a commission. The rate should be allowed to change when the direction of traffic pressure changes, since the service in the direction opposite to the direction of traffic pressure can be performed more cheaply.

Unnecessary Minor Improvements

Whether unity of railways is under Federal or corporate management, there are many advantages, aside from the elimination of wasteful competition, that may be shared by the railways and public, by such consolidation.

Three high-standard east-and-west transcontinental railways and probably four north-and-south lines could handle with much greater cheapness and dispatch the through business now handled by many lines. These high-standard lines could be made by reconstructing the best existing lines or by a combination of lines to the economic limit corresponding to the estimated traffic, other existing lines being operated as secondary or branch lines, handling only the traffic they originate and can handle best. The expenditure saved by abandoning contemplated line and gradient reductions, and projected lines into the territory served by other railways on many lines, might be sufficient to bring a few lines to the economic standard. Modern tunneling methods

and machinery make reduction of many gradients practicable, which reductions were formerly economically needed.

With traffic largely diverted to one route economies are practicable that cannot be obtained if this traffic is divided among many routes. The lines that give up the through traffic, becoming secondary lines, will still perform a useful and necessary part in the great railway whole, and will be performing a service for which they are probably better adapted than for through-line business. The creation of these suggested high-standard lines will produce a much greater traffic capacity than the same expenditure spread over many lines in minor improvements, some of which lines are perhaps hopelessly long, or have steep gradient lines.

It may not be too optimistic to hope that with the completion of a well-planned system of through routes, and common terminals well planned and adequate, forming part of a united, well balanced railway whole under corporate management, the saving will be such that rates can be reduced to the ante-bellum level without reducing wages, or that independent labor can be brought up to the union labor level; or, perhaps, if reduction is necessary, a percentage of earnings as a bonus may be a wise expenditure. After the war there will probably be for some years a period of surplus labor, at which time railway construction can be done cheaply and in the public interest. Preparation for the time after the war should begin now, at least so far as planning what is to be done with the railways is concerned and withholding expenditures not in harmony with this plan.

The railway system of the United States should be planned as a whole, assuming a common ownership of all railways, by a body of engineers, operating officials and bankers who are experts in railway economics. The working out of the economic railway plan for the nation, to supplant the plan and system developed by each railway for its own interest, is a very important peace preparation, requiring the best brains and training and all the time available, as well as the help and sanction of the Director General of Railroads.

Purdue Trains Concrete Foremen for Army Service

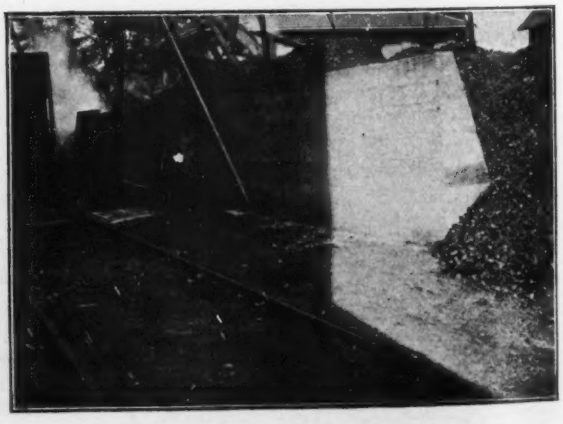
Practical Applications, Teaching To Do by Doing and Thinking, Used To Make Skilled Workmen in Eight Weeks

THE "how" rather than the "why" is the dominating feature of the vocational training in concrete work given to army students at Purdue University. The second contingent of 100 men is taking the eight-weeks' course in concrete work, while drill and military work are being taken by 500 auto mechanics and 150 embryo radio operators. Two main objectives in the concrete foremen's school were kept in mind in designing the course; first, the necessities of the army, and second, the preparation of the men to re-enter civilian life at the close of the war as small contractors or high-class superintendents for large contractors.

To care for 100 men, Purdue needed no additional equipment, for it had good existing facilities. The high-grade concrete laboratories of ten years' use are still ahead of those of most other institutions. Plenty of small concrete jobs about the campus, such as steps, sidewalks, conveyor tunnel and a water tower, were only awaiting forces of men to put them through. Housing facilities for all the men were provided by the erection of a mess hall, and sleeping quarters were amply provided for in the recently completed armory.

A staff was recruited from college instructors. The field superintendent obtained was a young contractor, a former student of Purdue, with broad engineering and executive experience but incapacitated for military service. The four sections of 25 men each were given six hours' work per day plus their regular drill periods.

As in most of the vocational schools started by the United States War Department's committee on training and instruction, the courses are so arranged that one thing at a time is given intensively, the student "learning to do by doing." Eight days are given indoors on arithmetic (for some of the men had forgotten even this branch of mathematics), blueprint reading, estimates, layouts, specifications, organization and lectures. In the field work 16 days are spent. Of this period six are on placing concrete, and three on form building, with one day each on unloading aggregate, excavating,



EMBRYO FOREMEN PLAN AND MAKE STEPS, AND BUILD COAL STORAGE WALL AND CONVEYOR TUNNEL

proportioning and mixing, organization and management, surface treatment, brick and stucco work, reinforcing and protection. Eight days are spent in the laboratory on tests of cement, aggregate, concrete beams, wood, steel, bond and sampling of a pit. Concrete products come in for four days' drill. Troughs, fence posts,

COMPRESSION TESTING IS LABORATORY EXERCISE

tile and slabs are made, and kinks in their construction are pointed out. A day in the shop is spent in learning the use, care and maintenance of saws, planes, chisels, squares, and other carpenters' tools. Straight edges, floats and darbies are made.

Some of the outdoor work includes the excavation under several full-size, four-panel flat slabs on columns which have recently been tested, inclosing the sides with brick, stucco or plaster on metal lath, and erecting a roomy storage building on top. An old wooden water tower was removed and one of concrete, designed by the engineering staff of the university, is in course of construction. At the time of a visit by a representative of *Engineering News-Record* the foundation had been poured and columns erected, ready for the form work of the tank proper. All work of reading blueprints, getting out forms, bending bars on a frame improvised by the students, handling the mixer and placing concrete, was carried out by them, each step being carefully planned, explained and worked out in advance by the whole class. Such stunts as unloading aggregate from a car, at ordinary speed and then at double speed, give the men accurate knowledge of the amount of material a man is able to handle in a given time.

The best men in the class receive advanced work, by having detailed to them squads for building unaided such small jobs as steps and sidewalk slabs. Only brief oral directions on the ground are given. Sketches must all be made, and estimates of quantities necessary with excavation and tools needed, must all be determined beforehand. This brings in personnel and gang organization ability.

In the pit-sampling tests, the men learn the quartering method, the use of ordinary sieves and Universal sand testers, silt tests, colorimetric tests and meaning, quality of gravel and how to make it acceptable for various purposes.

Talks or explanations precede all laboratory and practical work. For most of it mimeograph instructions are furnished. For inspection there is available a gravel-producing plant, a reinforced-concrete building under erection, monolithic and semi-monolithic brick paving under construction, and a planing mill.

Prof. W. K. Hatt is the supervisor in charge of the concrete school; R. C. Yeoman is assistant supervisor and W. F. Slattery is field superintendent.

Concrete Block River Mattresses Prove Economical

Capitalizing the Cost of Repairs for Japanese Rivers Proves This Type Cheaper Than Any Other

By B. Okasaki

Formerly Chief Engineer, Ishikari River Improvement Work, Japan, Now Civil Engineer, Home Department, Tokyo

CONCRETE block mattresses for river protection have been used for a number of years on the banks of some Japanese rivers, notably the Ishikari. The progressive steps in the application of this flexible mattress were outlined in articles in *Engineering News* of May 16, 1912, p. 922, and Mar. 13, 1913, p. 512. Since its first installation there has been an opportunity to compare its service and its cost with those of other types

FIG. 1. WEAVING CONCRETE BLOCK MATTRESS

FIG. 2. PILE AND FASCINE MATTRESS BROKEN BYRISE

of river-bank protection, and a recent analysis of the observations over a number of years of the various kinds of bank protection show the flexible block system to be most economical in the long run.

In deep rivers the concrete block mattress can be made cheaper in first cost than any other kind of substantial bank protection. However, notwithstanding the merits and advantages which the block mattress generally reveals when placed, one is sometimes forced not to adopt it in other places, particularly in shallow water, because of the slightly higher first cost in such locations. It has been found, though, that the cost of maintenance and repair of the less permanent types increase the final cost to more than that of the block type.

The chief merits of the flexible reinforced-concrete mattress lie in the fact that with this mattress no parts are lost from the attack of drift and scour, as the mattress settles down and fits the newly scoured river bed snugly and prevents further scour, so the only thing necessary is the additional expansion of the width of the mattress to compensate for the settlement. In the other types, parts of the piles, the cribs or the fascines are very liable to be lost *in toto* from the severe scour or term of 20 years was adopted as the standard from attacks of drift.

In the examination of costs only those works were examined that are constantly subject to severe attack of the current. The first cost and cost of maintenance and repair are considered since the year 1898. Optionally a

FIG. 3. LOG MATTRESS NEARING DESTRUCTION FROM RIVER RISE

FIG. 4. PILE AND FASCINE MATTRESS IN COURSE OF CONSTRUCTION

COMPARISON OF FIRST COSTS AND REPAIRS OF DIFFERENT TYPES OF RIVER BANK PROTECTION IN JAPAN

River	Tokachi	Tokachi	Ishikari	Ishikari	Yubari	Chubets
Locality	Obihiro	Obihiro	Fukagawa	Fukagawa	Yuni	Asahikawa
Depth of thalweg at low water	14 ft.	14 ft.	17 ft.	17 ft.	4 ft.	8 ft.
Flood height above low water	10 ft.	10 ft.	12 ft.	12 ft.	10 ft.	10 ft.
Construction	Pile and fascine mattress	Concrete mattress	Pile and fascine mattress	Concrete mattress	Concrete mattress	Pile and fascine mattress
Length of work	1,440 ft.	960 ft.	2,640 ft.	600 ft.	600 ft.	624 ft.
First cost of construction per ft.	$2.64	$3.97	$2.23	$7.34	$3.70	$2.58
Annual cost of repair per ft. run	$0.56	$0.12	$0.29	.....	$0.03	$1.97
Allotment of the first cost per ft. run in 20 years	$0.13	$0.20	$0.11	$0.37	$0.19	$0.13
Sum of the allotment and the annual cost of repair per ft. run	$0.69	$0.32	$0.40	$0.37	$0.22	$2.10

which to calculate the annual average of both the first cost and that of maintenance and repair for foot run of the river bank under protection. The interest is not considered, as the works were built with Governmental funds and cared for by the annual local tax. The sum of the annual allotment of the first cost and the cost of maintenance and repair is put in the last line in the accompanying table.

The accompanying views show the block and other mattresses under construction and in operation on Japanese rivers. Fig. 1 shows a concrete block mattress being knitted on the top of the slope of the river bank. A typical work consisting of combined pile and fascine mattress with a sloped pitching of willow hurdles filled by riprap, a part of which is damaged by the drift, is shown in Fig. 2. Fig. 3 shows a log mattress inclined in a critical condition and a part of the framework broken, and Fig. 4 shows a combined pile and fascine mattress with a sloped pitching of willow basket, or a kind of gabion filled with pebbles, in course of construction.

From the table it may be concluded that when a term of 20 years is adopted for a standard of comparison the flexible block concrete mattress is the most economical, provided the annual allotment as the first cost of construction, and the yearly cost of maintenance and repair are considered.

One Out of Three in the Service

Members of the United States Reclamation Service who had entered the military or naval service up to June 15, 1918, according to the *Reclamation Record* of August, 1918, totaled 503, or 30.7% of the employees of the department.

Garbage Collection and Disposal Under War Conditions

United States Food Administration Makes Country-Wide Survey—Kitchen Wastes of 382 Cities With Total Population of 30,000,000 Utilized

DATA SUMMARIZED AND DISCUSSED BY M. N. BAKER
Associate Editor of Engineering News-Record

COMPREHENSIVE data on garbage collection and disposal in cities of the United States having populations of 10,000 and more have been gathered by the garbage utilization division of the United States Food Administration. By means of an easy key system much information concerning the separation of garbage, whether systematic collections are made and by whom, and methods of disposal, has been compressed into small compass by the Food Administration while still bringing out clearly the main point, which is whether and how the garbage of the various cities is utilized.

Access to these valuable data having been kindly given to *Engineering News-Record*, the writer has summarized the primary information by states, groups of states and for the whole country. The summary tables are given below, together with the original or Food Administration tables and some comments designed to be interpretative. The Food Administration is responsible for the basic table only, Table III.

So outstanding is the fact, stimulated by war conditions, that garbage is being utilized and should be used now as never before, that the data on disposal will be considered first. No less than 382 cities with a combined population of nearly 30,000,000 are feeding garbage to hogs or reclaiming from it fats and fertilizer by means of reduction. This is most encouraging.

But it is discouraging to find that the garbage of 316 cities is not all being conserved at a time when the need for every possible ounce of food, fat and fertilizer is many times greater than ever before. Fortunately, the population the garbage from which is not being reclaimed is less than 14,000,000, or less than one-third the total of that of the 698 cities under consideration. Moreover, some portion of the garbage of about 450 cities is fed, although only 345 cities have their populations entered in the feeding column. This makes the case better for utilization, but some of the cities put in the feeding column do not make sure that all the garbage is fed.

REDUCTION PLANTS ARE IN LARGER CITIES

That it is mostly the larger cities which have reduction plants is shown by the fact that the 18,500,000 population totaled under reduction is in 37 cities while 345 cities, with 11,170,000 population, reported their garbage as being fed. Only 13 of the reduction works are in cities of less than 100,000 population, six in less than 50,000, and about half a dozen in places of less than 25,000. Sharpsburg, Penn., with 10,600 population, is the smallest city to report reduction works. Its garbage goes to the Pittsburgh plant. It appears that the number of reduction plants has not increased much during the war, as would be expected in view of their cost and the labor, material and time required to build them. Twenty-one of the 37 reduction works are in three states, New York, Pennsylvania and Ohio.

Indications are that feeding is rapidly increasing, cities turning to it from incineration and from the miscellaneous class of "burn, bury or dump." Feeding often produces some revenue for the city, while incineration is in most cases a dead expense, and in a probable considerable majority of the cities draws upon fuel which is much needed for military and industrial purposes.

On the 316 cities which do not utilize their garbage, 102 incinerate it in furnaces and 214 report miscellaneous means of disposal, lumped under "burn, bury or dump"—"burn" perhaps relating mostly to paper burned

TABLE I. LEADING METHODS OF GARBAGE DISPOSAL IN CITIES OF 10,000 POPULATION AND UPWARD, WITH NUMBER OF CITIES AND POPULATION BY STATES AND GROUPS OF STATES, BASED ON REPORTS TO THE UNITED STATES FOOD ADMINISTRATION

	Total Cities Included	Burn, Bury or Dump*		Incinerate		Feed		Reduce	
		No.	Population	No.	Population	No.	Population	No.	Population
Me.	11	1	8,400			10	211,300		
N. H.	7	1	13,600	1	14,700	5	135,300		
Vt.	3					3	41,400		
Mass.	69					67	2,187,400	2	895,000
R. I.	12	2	65,000			10	469,200		
Conn.	22	6	159,200			15	627,500	1	172,000
N. E.	124	10	246,200	1	14,700	110	3,672,200	3	1,067,000
N. Y.	51	22	630,700	5	658,600	19	449,500	5	6,237,000
N. J.	31	18	1,353,000	2	268,400	9	171,500	2	76,000
Penn.	57	23	412,200	13	696,400	15	368,900	6	2,499,200
Del.	1							1	110,000
Md.	5	3	47,400			1	25,700	1	590,000
D. C.	1							1	390,000
Mid.	146	66	2,443,300	20	1,623,400	44	1,015,600	16	9,902,200
Va.	10	3	88,000	6	427,900	1	17,800		
W. Va.	10	4	88,900	4	101,000	2	35,700		
N. C.	8	2	40,000	5	158,100	1	14,000		
S. C.	5	3	106,900	2	40,600				
Ga.	9	2	75,500	5	357,700	2	43,100		
Fla.	5	2	119,700	3	102,800				
S. A.	47	16	519,000	25	1,188,100	6	110,600		
Ala.	8	4	276,700	2	67,000	2	29,000		
Miss.	9	4	82,800	1	9,000	4	84,900		
La.	4	1	375,000	2	59,500	1	13,200		
Tenn.	6	3	113,900	2	169,300	1	133,100		
Ky.	12	6	359,000			6	367,500		
S. C.	39	18	1,207,400	7	1,504,800	14	627,700		
Ohio.	46	19	376,200	2	54,100	15	277,800	10	2,209,000
Ind.	34	10	194,100	5	165,800	16	305,000	3	397,600
Mich.	32	13	233,400	4	43,700	14	480,600	1	810,000
Ill.	43	16	427,000	7	218,100	18	462,200	2	2,676,800
Wis.	22	8	184,900	3	515,500	11	211,600		
N. C.	177	66	1,415,600	21	997,200	74	1,745,200	16	6,093,400
Ia.	17	2	68,000	4	163,000	11	303,800		
Minn.	12	3	34,600	3	130,000	6	643,000		
Kan.	16	1	24,000			15	397,800		
Neb.	6	1	55,000	1	11,800	4	205,300		
N. Dak.	2			2	43,800				
S. Dak.	3	2	25,200			1	24,000		
Wyo.	2	1	14,000			1	8,300		
Mont.	6	5	173,000	1	15,000				
N. W.	64	15	393,800	11	363,600	38	1,382,200		
Mo.	15					14	695,000	1	902,000
Ark.	6	5	100,100	1	57,300				
Tex.	23	4	209,800	8	466,200	11	297,800		
Okla.	3	2	33,900			6	254,400		
Colo.	7					7	397,800		
N. M.	1					1	14,000		
S. W.	60	11	343,800	9	523,500	39	1,963,000	1	902,000
Wash.	7	5	493,100	1	150,300	1	25,100		
Ore.	4					4	61,700		
Calif.	22	5	318,800	6	772,100	10	280,200	1	590,000
Ariz.	3	2	40,000			1	19,200		
Nev.	1					1	15,900		
Utah.	3			1	44,700	2	135,600		
Ida.	1					1	16,000		
Pac.	41	12	358,900	8	816,800	20	654,300	1	590,000
U. S.	698	214	6,928,000	102	7,032,100	345	11,170,800	37	18,554,000

*Burn presumably indicates burning paper and rubbish in the open, on dumps

in the open on dumps, and "dump" including both land and water dumping.

A considerable number of fair-sized cities report feeding: Six of 200,000 population or more (Kansas City, Minneapolis, St. Paul, Denver, Providence and Louisville); 20 of 100,000 or more; and 44 of 50,000 and more. Among the cities which report incineration four have populations of 200,000 or more (San Francisco, Milwaukee, part of New York City and Atlanta) while these and eight others, or 14 in all, have more than 100,000 population each. These 14 cities have a total population well toward 3,000,000. All are of sufficient size to support reduction plants, instead of burning wastes that might be reclaimed. However, their incinerators were built in pre-war times. The "burn, bury or dump" class numbers 10 cities of 100,000 population or more, with an aggregate population of about 2,500,000, all again readily in the possible reduction class. The largest of these, New Orleans, has had plans for reduction under way for months, and they are presumably delayed by war conditions. Seattle, next in size to New Orleans, built three high-temperature destructors years ago, which have been closed for some time except for the disposal of combustible refuse. The Seattle garbage goes to "sanitary fills," which the writer was informed several years ago were thoroughly satisfactory to both the local and state boards of health.

Geographically, the modes of disposal and corresponding populations are summarized in Table I. The New

TABLE II—SUMMARY OF GARBAGE COLLECTION AND DISPOSAL DATA FOR 785 CITIES OF 10,000 POPULATION AND UPWARDS BASED ON INFORMATION COLLECTED BY THE UNITED STATES FOOD ADMINISTRATION

	Total Cities Listed	Systematic Collection Yes	Systematic Collection No	Systematic Collection ??	Separate or Mixed Collection g	Separate or Mixed Collection ag	Separate or Mixed Collection rg	Separate or Mixed Collection arg	Collection by Municipality, Contract, Private or Combined m	c	p	mc	mp	cp	mcp	Private Collection Permitted or Prohibited pn	ppn	ppyn	ppy	nr	Disposal by Municipality, Contract, Private or Combined m	c	p	mx
Me	11	3	8		3		0	0	0	0			2	1		1	1			1				3
N. H	9	3	3	3	1		1	1	0				2	1		3								3
Vt	5	1	2	2			1			1										1			1	
Mass	70	59	10	1	59				10	20	5	2	5	16	1	15	11	6	19	8		8	17	5	29
R. I	12	6	6		6					2				4		3	1	1	1			0	2		4
Conn	27	20	2	5	14	1	2	3		5	2	1	6	6		14		2	2	2		1	3	2	14
N. E	134	92	31	11	83	1	4	4	10	28	7	3	15	28	1	36	13	9	23	11		9	23	7	53
N. Y	59	44	5	10	27		5	12	4	16	1		15	8		26	4	1	9	4		5	14	1	24
N. J	38	31	1	6	10	1	3	17	8	6		7	9	1		18	3	1	5	4		7	7	2	15
Penn	82	43	17	22	24		16	3	4	12	7	9		11		22	1	1	15	4		6	11	6	20
Del	1	1			1					1									1				1		
Md	5	5			2		2	1	1	3				1		4			1			1	3		1
D. C	1	1			1					1									1				1		
Mid	186	125	23	38	65	1	26	33	17	39	8	16	24	21		70	8	3	32	12		19	37	9	60
Va	10	9	1		1	1	4	3	3				6			6	1	1		1		4			5
W. Va	10	6	3	1	3		2	1	2	1			1	2		3		1	1	1		1	1		4
N. C	12	6	2	4	2		2	2	3				3			4				2		3			3
S. C	12	6		1	1			4	2				3	4		5						2			3
Ga	11	8	1	2	1		1	6	3		1		4			6				2		2		1	5
Fla	5	5					5		2	1			2			2	1		1	1		2			3
S. A.	60	39	7	8	8	1	14	16	15	2	1		13	6		26	2	2	2	7		14	1	1	23
Ala	8	7	1		1		5	1			1		6			6				1					7
Miss	9	6	3		2		3	1	2			1	3			4			1	1		4			2
La	6	3	1	2			2	1	1				2			2			1						3
Tenn	7	6	1		1		4	1					6			4	2								6
Ky	11	7	4		3	1	1	2	3	1			2	1		4			1	2		3			4
S. C	41	29	10	2	7	1	15	6	6	1	1	1	19	1		20	2		3	4		7			22
Ohio	52	34	12	6	24	1	4	5	5	7	1		7	14		17	7		4	6		5	7		22
Ind	35	30	4	1	22		5	3	5	5			12	8		15	4	1	4	6		2	3	1	24
Ill	43	33	10		18		8	7	2	3	1		21	6		28	2		3	0		3	2	1	27
Mich	33	25	8		13		6	6	9	5	3		3	4	1	11	1		7	6		9	3	3	10
Wis	23	16	6	1	9		5	2	1		1		11	3		13		1		2		4	1	2	9
N. C	186	138	40	8	86	1	28	23	22	20	6		54	35	1	84	14	2	18	20		23	16	7	92
Ia	19	10	6	3	4		4	2					6	3	1	8		1		1		1			9
Minn	12	8	4		3		4	1	2	1	1	1	3			3	1		1	3		3	1		4
Kan	16	7	9		5		2			3			1	3		3	1		2	1			2	1	4
Neb	6	4	2		2		2			1				3			2		1	1			2		2
N. D	2	2			1		1		1					1		1				1					2
S. D	3	2	1				1	1					1	1		2							1		
Wyo	3	1	1	1	1					1									1						1
Mont	6	4	2		1		1	2	3				1			3	1					3			
N. W	67	38	25	4	17		15	6	6	6	1	1	12	11	1	20	5	1	5	7		7	6	1	24
Mo	15	4	10	1	4					2			1	1		2	1		1				1	3	
Ark	6	5	1		1		4		1	1			2			2			1	2		1		1	3
Tex	27	13	11	3	4		8	1	5		2		3	3		7	1	1	1	3		5		2	6
Colo	7	5	2		4		1			4	1					1	1	1	2				3	1	1
N. M	1	1			1					1										1			1		
Okla	10	5	2	3	3		2			2			2	1		1	2	1		1			2		3
S. W	66	33	26	7	17		15	1	6	10	4		8	5		13	5	3	5	7		6	7	7	13
Wash	10	6	1	3	2			4		1		1	1	3		4		1		1					6
Ore	5	1	3	1	1									1			1								1
Calif	22	20	2		8		8	4	1	8	9		1	1		8	4		6	2			5	4	11
Ariz	3	3					1	2	1	1			1			2			1			1	1		1
Utah	3	1	2		1									1		1									1
Ida	2	1	1		1									1		1									
Pac	45	32	9	4	13		9	10	2	10	9	1	3	7		16	5	1	7	3		1	6	4	21
U. S.	785	526	171	82	296	5	126	99	84	116	37	22	148	114	3	285	54	21	95	71		86	96	36	308

Under Systematic Collection the column headed "??" gives number which did not report on this subject. In all but one of the other column groups only those cities which reported a systematic collection are included.

Under Separate or Mixed Collection "g" indicates that garbage is collected separately; "ag" that ashes are mixed with garbage; "rg," rubbish and garbage mixed; "arg," all three mixed.

Under Collection by Municipality, etc., "m" denotes municipality; "c" contract; "p," private, and the other column heads indicate combinations.

Under Private Collection Permitted, etc., "pr" means private collectors not prohibited; "ppn," prohibited, but not enforced; "ppyn," prohibited by ordinance and not enforced; "ppy," ordinance enforced; "nr," no report.

Under Disposal by, etc., "m," "c," "p," indicate municipality, contract, private, respectively and "mx" means various combinations.

England States lead in feeding; the Middle in reduction; the South Atlantic in number and the Middle in population under the same heading. By states, Massachusetts is far in the lead in feeding, with 67 cities and towns in that class, or all reporting except Boston and New Bedford, the garbage of which is reduced. Further geographical contrasts of disposal methods may be drawn from Table I by those interested in groups of states. Table III, the basic table, compiled by the Food Administration, gives disposal data by cities for the whole country, the states being arranged alphabetically and the cities placed in like order under each state.

Systematic Collection Reported in 526 Cities

The disposal data already discussed are simple compared with the combined information on collection and disposal presented in condensed form with the aid of key letters in Table III and summarized by the writer in Table II.

From Table III it appears that of 785 cities and towns having 10,000 population or more 526 reported systematic collection of garbage, 171 no collection and 82 failed to report. Considering the number of small places in the list, this might be regarded as a good showing, even though many cities have no collection. Study of the additional symbols, indicating whether the collection is by the municipality, by contract, by private arrangement with individual householders, or by a combination of two or all three of these methods, indicates that "systematic collection," as reported by many of the cities, may not go very far. This conclusion is strengthened by an examination of the summaries under the columns which show whether private collection is permitted or prohibited, and if the latter, whether the prohibition is enforced.

Of 626 cities which report systematic collection, 285 do not forbid private collection, 75 prohibit it but do not enforce the rule, 71 make no report on the subject and only 95 lay claim to prohibition without enforcement. These figures certainly tend to show that much must yet be done before American cities have anything like thoroughgoing garbage collection—and until that is had the presumption is that large quantities are not properly collected and that a considerable proportion of this total is not available for utilization.

Separate Collection of Garbage in 296 Cities

Garbage is collected separately in 296 of the 526 cities reporting systematic collection; with ashes in five, with refuse in 196 and with both ashes and refuse in 99. Here again lack of thorough collection and full and fair chance for utilization is apparent, for garbage cannot be thoroughly utilized for feeding or reduction unless it is kept and collected free from other wastes. A total of 382 cities, we have already seen, report feeding or reduction of garbage, against only 296 in which garbage is collected separately.

Municipal collection is generally considered by sanitarians to be the best plan, and contract collection the next best. Only 84 of the 526 cities report municipal collection alone, against 116 contract and 37 private and 287 mixed. Some part or all of the garbage is collected by the municipality in 257 cities, some part by contract in 255 and some part privately in 302 of the 526 cities.

Disposal is reported as by the city alone in 86 cases; by contract alone in 96; privately in 36 and mixed in 308 cases. Here also there is opportunity for advance.

Those who desire to pursue the subject can summarize for themselves how the cities, the contractors and the private scavengers each dispose of the garbage they collect.

Altogether, the garbage utilization division of the United States Food Administration has done a large amount of valuable work in collecting and compiling the garbage data presented in Table III. The survey will stimulate better and more complete methods of garbage collection, besides accelerating the utilization of kitchen wastes either by feeding or by reduction, which is the worthy object of the investigation.

Finally, corrections and additions to Table III are desired. These should be sent directly to the United States Food Administration, Washington, D. C.

TABLE III. GARBAGE COLLECTION AND DISPOSAL IN CITIES OF 10,000 POPULATION AND UPWARDS—INFORMATION COLLECTED BY THE GARBAGE UTILIZATION DIVISION OF THE UNITED STATES FOOD ADMINISTRATION

	Collection*	Disposal†	Population‡
ALABAMA			
Anniston	sgmp-pn	mgf-pf	17.0F
Bessemer	srgmp-pn	md-pf	16.5B
Birmingham	sargmp	md-pf	181.0B
Gadsden	srgp-pn	md-pf	15.5I
Mobile	srgmp-pn	md-pf	60.0B
Montgomery	srgmp-pn	mid-pf	51.5I
Selma	srgmp-pn	md-pf	19.2B
Tuscaloosa	No	pf	12.0F
ARIZONA			
Bisbee	sargmp-pn	md-pf	18.0B
Phoenix	srgc20-ppy	cf	19.2F
Tucson	sargm-pn	md	22.0B
ARKANSAS			
Argenta	No	cd	18.1B
Fort Smith	srgm-ppy	md	28.7B
Helena	sgmp-pn	md-pd	12.0B
Hot Springs	srgc27p	cd-pf	17.2B
Little Rock	srgmp-pn	mi-pf	57.3I
Pine Bluff	srgp	pd	24.1B
CALIFORNIA			
Alameda	sargp-pn	pd	32.0B
Bakersfield	sgc-21-ppy	cf	20.0F
Berkeley	sargp-pn	pmi-pf	65.0I
Eureka	No	pf	17.2F
Fresno	sargp-pn	pci-pf	48.9I
Long Beach	sgc-19-ppy	cf	27.0F
Los Angeles	sgm-ppy	mcr	596.0R
Oakland	srgc18-ppn	cd-pf	210.0B
Pasadena	srgmp-ppn	mcf-mcr-pf	42.3F
Pomona	sgc19-ppy	cf	14.3F
Redlands	sgc20-ppy	cf	21.0F
Riverside	sgcp-pn	cb-pf	19.8B
Sacramento	srgp	pmi	75.0I
San Bernardino	No	pf	18.8F
San Diego	sgc20p-ppn	cf-pf	90.0F
San Francisco	srgp-pn	pmi-pf	416.2I
San Jose	sargcp-ppn	cmi-pf	40.4I
Santa Ana	srgc19-ppy	cf	15.4F
Santa Barbara	sgp-pn	pf	14.8F
Santa Cruz	srgp	nmi-pf	12.6I
Stockton	srgp-pn	pd	42.0B
Vallejo	srgp-pn	pd	15.0B
COLORADO			
Boulder	sgc24-ppn	cf-pf	12.0F
Colo. Spgs.	sgc18	cf	36.0F

* Under "Collection" "s" indicates that there is a systematic collection and "no" that there is not; "g" stands for garbage, "a" for ashes and "r" for rubbish, while combinations of these letters mean that ashes or rubbish or both are collected with the garbage. In the same column "m," "c" and "p" denote municipal, contract and private collection respectively, and a combination of these letters indicates that more than one system of collection is in use. When "c" is followed by a figure, as "c 20" it means that the collection contract expires in 1920. Letters in the collection column following a dash show whether private collection is permitted or prohibited, and if prohibited whethr the prohibition is enforced. Thus "pn" means private collection not prohibited; "ppn," prohibited but not enforced; "ppyn," prohibited by ordinance but not enforced; "ppy," prohibited ordinance enforced.

† Under "Disposal" "m," "c" and "p" mean that disposal is by the municipality, by contract or private, while "d" means dumping on land or in water; "b" burning by some unstated method, presumably in the open; "f," feeding; "r," reduction. In the same column, "mgf" means municipality gives the garbage it collects to private parties for feeding; "m a f" means municipality sells to farmers, presumably for feeding; "mscf," municipality sells to contractor who sells to farmers; "pf," private feeding, etc.

‡ Under "Population," the entries are to the nearest hundred. The letters following indicate what is believed to be the prevailing method of disposal; "B" means burn (probably in the open), bury or dump, the latter on land or in water; "I" indicates incinerate in some form of furnace; "F" denotes feeding; "R" shows that the garbage is reduced for the recovery of grease and fertilizer base.

	Collection*	Disposal†	Population‡
Denver	sgc19-ppy	cf	260.8F
Ft. Collins	sgc27-ppy	cf	12.0F
Greeley	No		11.0F
Pueblo	srgp-ppyn	pf	51.0F
Trinidad	No srgp-pn	pf	15.8F
CONNECTICUT			
Ansonia			
Bridgeport	sgc25p-ppyn	cr-pf	172.0R
Bristol	sgmp-ppyn	msf-pf	19.0F
Danbury	No	pd-pf	23.5B
Derby			
East Hartford	sg-pn	csf	7.0F
Enfield	sgcp	cf-pf	11.2F
Greenwich			
Hartford	sgmp-pn	msf-pf	154.3F
Manchester	sgc	csf	17.0F
Meriden	sagc18p-pn	cd-pf	30.0B
Middletown	sargmp-pn	md-pf	13.5B
Naugatuck	sgc19p-pn	cf-pf	15.3F
New Britain	sgc-ppy	cf	58.2F
New Haven	sgmc18-ppy	msf-cf	165.0F
New London	sgc18p-pn	cf-pf	24.7F
Norwalk	sargm-pn	md	27.0B
Norwich	srgmp-pn	md-pf	29.4B
Orange	sgp-pn	pf	15.3F
Stamford	sargmp-pn	md-pd	35.8B
Stonington			
Torrington	srgc-pn	cf-pf	20.5F
Vernon			
Wallingford	No	pf	10.0F
Waterbury	sgmp-pn	mf-pf	87.0F
Winchester	sgp-pn	pf	9.7F
Willimantic	sgc18p-pn	cf-pf	13.3F
DELAWARE			
Wilmington	sgc17-ppy	cr	110.0R
DIST. COLUMBIA			
Washington	sgc18-ppy	cr	390.0R
FLORIDA			
Jacksonville	sgrmp-ppn	mb-pf	107.7B
Key West	srgc19	cmi	21.7I
Pensacola	srgm-pn	mi	28.9I
Tampa	srgmp-pn	mi-pf	52.2I
West Tampa	srgm-ppy	mb	12.0B
GEORGIA			
Albany			
Americus	srgmp-pn	mi-pf	10.9I
Athens	No	pf	22.4F
Atlanta	sargmp-pn	mi-pf	200.0I
Augusta	sargm-pn	md	55.0B
Brunswick			
Columbus	sargmp-pn	mid-pf	26.0I
Macon	sargmp-pn	mi-pf	45.8
Rome	sgp-pn	pf	19.7F
Savannah	sargm	mi	75.0I
Waycross	sargmp	mp-pf	20.5B
IDAHO			
Boise	No		
Pocatello	sgc23p-pn	cf-pf	16.0F
ILLINOIS			
Alton	No	pf	27.0F
Aurora	sgmp-pn	mi-pf	37.0I
Belleville	sgc-pn	cr-cf	24.8R
Bloomington	srgmp-pn	mf-pf	28.0F
Blue Island	sargmp-pn	md-pf	11.0B
Cairo	sgmp-pn	msef	16.0
Canton	srgmp-ppn	md-pf	13.3B
Centralia	No	pf	11.5F
Champaign	No	pf	14.5F
Chicago	sgmp-pn	mr-pr-pd	2,652.0R
Chicago Hts.	sgmp-pn	mi-pf	23.6I
Cicero	sargp-pn	pd	39.4B
Danville	No	pf	32.0F
Decatur	No	pf	39.7F
Dekalb	sgmp-pn	mf-pf	8.1F
E. St. Louis	sgc19p-pn	cf-pf	92.0F
Elgin	srgmp-pn	mi-pf	27.8I
Evanston	sgmp-pn	mspf-pf	28.5F
Freeport	sgmp-pn	md-pf	17.0B
Galesburg	sgc18p-pn	csf-pf	24.0F
Granite City	sgc20-pn	cf	18.0F
Jacksonville	sgcp-pn	cf-pf	15.4F
Joliet	srgmp-pn	mi-pr	47.7I
Kankakee	srgmp-pn	md-mf-pf	19.0F
Kewanee	sgmp-pn	md-pf	16.8B
LaSalle	sargmp-pn	md-pf	12.5B
Lincoln	No		12.2B
Mattoon	srgmp-ppn	mi-pf	14.0I
Maywood	srgc18p-pn	cb-pf	11.6B
Moline	sgmp-pn	mcf	30.0F
Monmouth	No	pf	10.2F
Mt Vernon	No	pf	10.0B
Oak Park	srgm-ppy	mi	35.0I
Ottawa	sargm-ppy	md	13.0B
Pekin	No	pd	13.0B
Peoria	sargmp-pn	md-pf	73.0B
Quincy	sgc18p-pn	cf-pf	36.8F
Rock Island	sgmp-pn	mi-pf	30.0I
Rockford	sgcp-pn	cd-pr-pf	59.0B
Springfield	sargmp-pn	md-pf	61.2B
Streator	sgc18-ppy	cd	15.0B
Urbana	No	pf	11.5F
Waukegan	sargmp-pn	md-pf	22.1B
INDIANA			
Anderson	sgm-ppy	mcf	32.5F
Bedford	No	pf	10.3F
Bloomington	srgmp-pn	md-pf	28.0B
Brazil	No		11.0B
Columbus	sargmp-ppny	md-pf	11.8B
Crawfordsville	No	pf	11.2F
E. Chicago	srgmp-ppn	mi-pf	36.0I
Elkhart	sgc	csf-pf	23.0F
Elwood	sgm	md	11.0B
Evansville			
Ft. Wayne	sgmp-pn	mcr-pf	80.0R
Frankfort	sgc19-ppy	cf	9.6F
Gary	sargmp-ppn	mf-pf	16.8F
Goshen	sgc	cf	9.0F
Hammond	sgm-pn	md	30.0B
Huntington	sgmp-pn	mi-pf	16.5I
Indianapolis	sgc18p-ppn	cr-pf	300.0R
Jeffersonville	sgcp-pn	cf-pf	10.4F
Kokomo	sgc	cf	21.0F
Lafayette	srgmp-pn	mi-pf	21.3I
Laporte	No	pd	15.9B
Logansport	sgc18p-ppn	cd-pf	22.0B
Marion	sgmp-pn	md-pf	22.0B
Michigan City	srgc18p-pn	pf	20.0F
Mishawaka	sgmp-pn	md-pf	17.0B
Muncie	sgm	mcf	25.5F
New Albany	sargmp-pn	md-pf	27.4B
New Castle	sgc	cf-csf	13.2F
Peru	sgcp-pn	cf-pf	14.0F
Richmond	sgmp-pn	mi-pf	26.0I
Shelbyville	sgc19p-pn	cf-pf	10.5F
South Bend	sgm-ppy	mscf	71.0F
Terre Haute	sgmp-pn	mi-pf	66.0
Vincennes	sgcp-ppy	cr-pf	17.6R
Wabash	srgc18p-pn	cgf-pf	10.0F
IOWA			
Boone			
Burlington	sgm19p-pn	cf and d-pf	25.0F
Cedar Rapids	srgmp-pn	md-pf	42.0F
Clinton			
Council Bluffs	sargc19p-pn	cf and d-pf	35.0F
Davenport	sgmp-pn	md-pf	52.0B
Des Moines	srgmp-pn	mi	100.0I
Dubuque	sgc28p-pn	ci-pf	43.0I
Ft. Dodge			
Ft. Madison	No	pf	9.7F
Iowa City	sgmcp-pn	mcf-pf	23.1F
Keokuk	srgcp	cd-pd	16.0B
Marshalltown	No	pf	16.1F
Mason City	srgmp-ppyn	mbf-pf	20.0I
Muscatine	No	pf	18.7F
Oskaloosa	No	pf	10.5F
Ottumwa	No	pf	23.0F
Sioux City	sargmp-pn	mf-pf	65.0F
Waterloo	No	pf	36.7F
KANSAS			
Atchison	sgcp-ppn	cf-pf	16.8F
Chanute	No		12.5F
Coffeyville	No	pf	17.6F
Emporia	sgc-pn	cf	10.9F
Ft. Scott	srgc-ppy	cf	12.0F
Hutchinson	No	pf	20.8F
Independence	No	pf	14.5F
Iola	sgcp-pn	cf-pf	11.1F
Kansas City	No	pf	99.4F
Lawrence	sgcp-pn	cf-pf	13.5F
Leavenworth	srgmp	md-pf	24.0B
Parsons	No	pf	16.9F
Pittsburgh	No	pf	19.8F
Salina	No	pf	12.6F
Topeka	sgc-ppy	pf	48.7F
Wichita	No	pf	70.7F
KENTUCKY			
Ashland	srgm-pn	mb	14.0B
Bowling Green	No	pf	9.8
Covington	sgm	mscf	56.5F
Frankfort	No	pf	12.3F
Henderson	sargc-22	md	15.0B
Hopkinsville	No	pd	10.7B
Lexington	sgc18p-pn	cb-pf	41.1B
Louisville	sargmp-pn	mf	246.3F
Newport	sagmp-pn	mb-pf	31.9B
Owensboro	sgm-ppy	smf	17.8F
Paducah	No	pf	24.8F
LOUISIANA			
Alexandria			
Baton Rouge	sargmp-pn	mi-pf	22.9I
Lake Charles			
Monroe	No	pf	13.2
New Orleans	srgm-ppy	md-mr	375.0B
Shreveport	srgmp-pn	mi-pf	36.6I
MAINE			
Auburn	No	pf	17.1F
Augusta	No	pf	15.0F
Bangor	No	pf	26.7F
Bath	No	pf	9.3F
Biddeford	No	pf	17.7F
Lewiston	sgcp-pn	cf-pf	27.8F
Portland	sgmp-ppn	mf-pf	64.7F
Rockland	sgmp	md-pf	8.4B
Sanford	No	pf	10.9F
Waterville	No	pf	12.7F
Westbrook	No	pf	9.4F
MARYLAND			
Annapolis	srgc18-pn	cd	10.0B
Baltimore	sgm-ppy	mcr	590.0R
Cumberland	srgcp-pn	cb-pf	26.6B
Frederick	sargc19-pn	cd	10.5B
Hagerstown	sgc18-pn	csf	25.7F
MASSACHUSETTS			
Adams	sgm	mf	14.2F
Amesbury	No	pf	10.2F
Arlington	sgm	mscf	12.8F
Athol	No	pf	11.5F
Attleboro	sgcp-ppyn	cf-pf	19.3F
Beverly	sgc20-ppy	cf	23.0F
Boston	sgmc19p-ppn	mcr-pf	775.0R
Braintree	sgc19-ppy	cf	10.0F
Brockton	sgm-ppn	mf-pf	63.5F
Brookline	sgc 21 ppy	cf	34.5F
Cambridge	sgm-ppn	msf-pf	121.8F
Chelsea	sgc22-ppy	cf	46.2F
Chicopee	sgmp-pn	msf-pf	30.0F
Clinton	sgc18-pn	cf	13.1F
Danvers	sgc18-ppy	cf	11.0F
Dedham	sgc20-ppy	cf	11.0F
Easthampton	sgc	cf	10.3F
Everett	sgc19	cf	40.0F
Fall River	sgc22-ppy	cf	131.4F
Fitchburg	sgc18-pn	cf-pf	40.5F
Framingham	sgc20-ppy	cf	14.0F
Gardner	sgcp18-pn	cf-pf	17.1F
Gloucester	sgc23-ppyn	cf-pf	24.6F
Greenfield	sgc20p-ppn	cf-pf	14.4F
Haverhill	sgc20-ppy	cf	55.1F
Holyoke	sgc19-ppyn	cf-pr	62.3F
Lawrence			
Leominster	sgc18p-ppn	cf-pf	17.6F
Lowell	sgmp-ppyn	msf-pf	108.0F
Lynn	sgmc-ppy	msf-csf	96.0F
Malden	sgm-ppy	mscsf	50.1F
Marlboro	No	pf	15.6F
Medford	sgp	pf	33.5F
Melrose	sgc20-ppn	cf	18.0F
Methuen	sgmp-pn	mf-pf	13.9F
Middleboro	sgc-ppy	cf	10.0F
Milford	sgp-pn	pf	14.1F
Natick	sgc19p-pn	cf-pf	12.4F
New Bedford	sgm-ppy	mcr	120.0R
Newburyport	sgp-pn	pf	15.3F
Newton	sgc18p-pn	cf-pf	43.7F
North Adams	sgcp-pn	cf-pf	23.0F
Northampton	sgc18p-pn	cf-pf	21.7F
N. Attleboro	No	pf	11.0F
Northbridge	sgp	pf	9.9F
Norwood	No	pf	12.8F
Palmer	No	pf	10.0F
Peabody	sgp	pf	20.0F
Pittsfield	sgc19-ppy	cf	38.6F
Plymouth	No	pf	13.7F
Quincy	sgm-ppy	msf	45.0F
Revere	sgc19p-ppn	cf-pf	27.0F
Salem	sgmp-ppyn	mscsf-pf	42.0F
Saugus	sgc19p-ppyn	cf-pf	10.4F
Somerville	sgm-ppy	msf	90.2F
Southbridge	sgc20p-ppn	cf-pf	13.3F
Springfield	sgm-ppy	msf	105.9F
Taunton	sgmp-pn	mf-pf	36.3F
Wakefield	sgc20p-ppn	cf	12.7F
Waltham	sgc22p	cf-pf	30.6F
Ware	No	pf	9.4F
Watertown	sgc19p-ppn	cf-pf	20.5F
Webster	No	pf	13.2F
W. Springfield	sgcp-pn	cf-pf	12.0F
Westfield	sgc18p-ppn	cf-pf	19.5F
Weymouth	No	pf	14.0F
Winchester	sgm-ppy	mscf	10.9F
Winthrop	sgc18-pn	cf	12.8F
Woburn	sgc18-ppy	cf	16.0F
Worcester	sgmp-pn	mf-pf	185.0I
MICHIGAN			
Adrian	sgc19p-pn	cf-pf	10.8F
Alpena	No	pf	12.7F
Ann Arbor	sgc22p-pn	cfd-pf	18.3F
Battle Creek	sargcp-pn	cf-pf	34.2F
Bay City	No	pd	47.9B
Benton Harbor	sgm-pn	mi	12.0I
Cadillac	No	pf	10.0F
Detroit	sgm-ppy	mcr	810.0R
Escanaba	srgc-ppy	cd	15.4B
Flint	sgc-ppy	cf	54.7F
Grand Rapids	sgm-ppy	mscf	130.0F
Hancock	sargm-pn	md	10.0B
Holland	sgc		12.3B
Iron Mountain	sgm	mi	9.2I
Ironwood	sargmp-pn	md-pd	14.7B
Ishpeming	srgmp-pn	mi-pf	12.5I
Jackson	sargp-pn	pf	35.4F
Kalamazoo	sargmpc-18	md-pf	51.2B
Lansing	sgmp-pn	mf-pf	37.5F
Laurium	sargm	mb	10.3B
Ludington	srgcp-pn	cf-pf	10.4F
Manistee	No	pd	12.3B
Marquette	srgm-ppy	md	13.0B
Menominee	srgm-ppy	md	12.8B
Muskegon	srgp-pn	pf	41.5F
Negaunee	sgm	md	10.1B
Owosso	sgc-pn	cf-pf-pd	
Pontiac	sgc-18ppy	cf	15.6F
Port Huron	sgp	pd	18.9B
Saginaw	No	pf-pr	64.5F
Sault Ste. Marie	No	pd	14.5B
Traverse City	No	pf	13.0F
Wyandotte	No	pf	10.3
MINNESOTA			
Brainard	No	cd	9.1B
Duluth	srgmp-pn	mi-pi	98.5I
Faribault	No	pf	11.0F

	Collection*	Disposal†	Population‡
Hibbing	argmp	mi-pf	16.4I
Mankato	agmc-pn	md-cd-csf	14.4B
Minneapolis	argm	msf	315.3F
Red Wing	sargcp-ppn	cd-pf	10.1B
St. Cloud	agc18-ppy	cf	15.5F
St. Paul	agmp-pn	mscf	272.0F
Stillwater	No	pf	10.6F
Virginia	argm	mi	15.5I
Winona	No	pf	18.6F
MISSISSIPPI			
Biloxi	argm-pn	md	9.7B
Columbus	sargmp-pn	mi-pf	9.0I
Greenville	No	pf	12.1F
Hattiesburg	agm-ppy	mi	16.5B
Jackson	argmp-pn	pf-mf	31.0F
Laurel	No	pf	11.8F
Meridian	No	pf	30.0F
Natchez	srgmp-pn	md-pf	33.8B
Vicksburg	agmc	md	22.8B
MISSOURI			
Cape Girardeau	No	pf	10.8F
Carthage	No	pf	10.8F
Columbia	No	pf-pp	12.5F
Hannibal	No	pf	20.0F
Independence	No	pf	12.5F
Jefferson City	No	pf	15.0F
Joplin	agc-21-ppn	cf-pf	33.2F
Kansas City	agc18p-pn	cf-pf	391.0F
Moberly	No	pf	12.8F
St. Charles	No	pf	10.3F
St. Joseph	No	pf	85.2F
St. Louis	agmp-pn	mcr-pr-pf	902.0R
Sedalia	No†	pf	27.2F
Springfield	agc-ppy	cf	39.9F
Webb City			13.8F
MONTANA			
Anaconda	No		10.6B
Billings	sargm-pn	md	16.1B
Butte	srgm-ppn	mi	100.0B
Great Falls	sargmp-pn	md-pf	29.1B
Helena	sgm-pn	mi	15.0I
Missoula	No		17.2B
NEBRASKA			
Beatrice	srgc-36-ppy	ci	11.8I
Fremont	No	pf	12.0F
Grand Island	No	pf	15.0F
Hastings	agc22p-ppn	cf-pb	12.8F
Lincoln	srgc	cd	55.0B
Omaha	agc18p-ppn	cf-pf	165.5F
NEVADA			
Reno	No	pf	15.9F
NEW HAMPSHIRE			
Berlin	srgmp-pn‖	mi-pf	14.7F
Concord	cf or pcol.		22.0F
Dover			
Keene	No	pf	10.6F
Laconia	sargmp-pn	md-pf	13.6B
Manchester	sgpc-pn	cf-pf	80.1F
Nashua			
Portsmouth	No	pf	13.5F
Rochester	No	pf	9.1F
NEW JERSEY			
Asbury Park	agc18p-ppn	cf-pf	14.0F
Atlantic City	srgc21p-ppn	cr-pf	60.0R
Bayonne	sargm-pn	md	78.6B
Belleville	sargc19-pn	cd	12.4B
Bloomfield	sargmp-pn	md-pd	17.2B
Bridgeton			
Burlington			
Camden	sgm	md	106.2B
East Orange	sargmcp-pn	mdi-pd	42.4B
Elizabeth	sargc-19	cd	88.8B
Englewood	sgcp-pn	cf-pf	11.7F
Garfield	sagm	md	18.0B
Gloucester	sargmp-pn	md-pf	11.5B
Hackensack	sargp	pd	17.0B
Harrison	sgc19-ppy	cd	16.4B
Hoboken	sargc18-pn	cd	72.0B
Irvington	srgm-ppy	mcsf-pf	25.0F
Jersey City	sargc22p-pn	cd	316.9B
Kearny	sargm-pn	md	25.0B
Long Branch	agc21p-ppn	cr-pf	16.0R
Millburn	sargm-pn	md	
Millville	No	pf	15.5F
Montclair	sgm-ppy	mcf	26.0F
Morristown	agc19-ppy	cf	13.0F
New Brunswick	sgmp-pn	mgf-pf	25.5F
Newark	sargmp-pn	md-pf	410.5B
Orange	sargc18p-pn	cd-pd	33.0B
Passaic	sargm-pn	md	70.1B
Paterson	sargmp-pn	mi-pd-pr	137.6I
Perth Amboy	srgc19-ppy	cd	45.1B
Phillipsburg			
Plainfield	sgcp-pn	pf	26.0F
Rahway	sargmp-pn	md-pd	10.2B
Trenton	sargmp-pn	mi-pf	120.8I
Union			
West Hoboken			
West New York			
West Orange	sgcp-ppn	cf-pf	14.8F
NEW MEXICO			
Albuquerque	sgc	csf	14.0F

	Collection*	Disposal†	Population‡
NEW YORK			
Albany	sgmcp-pn	mcf-pf	110.0F
Amsterdam	srgm-ppy	mi	37.1I
Auburn	agmp-pn	md-pf	37.4B
Batavia	srgmp-ppn	mi-pi	13.0F
Beacon	sargc-18pn	cd	11.6B
Binghamton	agmp-pn	mgf-pf	53.7F
Buffalo	agmp-pn	mr-pf	500.0R
Cohoes	sargc-20-pn	cd	23.4B
Corning	agc-ppy	cf	15.4F
Cortland	agc-19p-pn	cf-pf	11.5F
Dunkirk	agc-19-ppy	cf	20.2F
Elmira			
Fulton	sargp-pn	pd	14.4B
Geneva			
Glens Falls	No	pf	16.9F
Gloversville	srgc18-ppy	cd	22.1B
Hornell	sgc	cf	14.6F
Hudson	sgcp-ppyn	cf-pf	12.0F
Ithaca	sargmp-pn	md-pf	17.5B
Jamestown	sgcp-pn	pf-cf	37.8B
Johnstown	srgc18-pn	cd	10.0B
Kingston	sgmp-ppy	mgf-pf	26.9F
Lackawanna	sargc18-ppy	cd	18.0B
Little Falls	sgcp-pn	cf-pf	13.0F
Lockport	sargmp-pn	mgf-pf	20.5F
Middletown	agc19-pn	cd	15.8B
Mt. Vernon			
New Rochelle			37.0I
New York City			
Manhattan, Bronx, Brooklyn	sgmp-pn	mr-pr-pf	5,270.0R
Queens	sargmp-pn	mi-md	379.7I
Richmond	sargmp-pn	mi	105.0I
Newburgh	sgc	cf	29.6F
Niagara Falls	sargm-pn	md	37.3B
North Tonawanda	agc18-ppy	cd	14.0B
Ogdensburg	No	pd-pf	16.7B
Olean	sgc20-ppn	cf-pf	20.0F
Oneida			
Oneonta	sgc	cf	10.5F
Ossining			
Oswego	No	pd	24.5B
Peekskill			
Plattsburg	No	pf	11.1F
Port Chester			
Port Jervis	sgmp-pn	md-pf	9.7B
Poughkeepsie			
Rensselaer	agc19p-pn	cf-pf	11.4F
Rochester	sgm-ppy	mr	275.0R
Rome	agc21p-pn	cf-pf	25.9F
Saratoga Spgs	No	pf	13.8F
Schenectady	sgmp-ppn	mr-pf	102.0R
Syracuse	sgmp-ppn	md-pf	150.0B
Tonawanda	sargc19-pn	cd	9.2B
Troy	sargmp-pn	md-pf	78.1B
Utica	sgc21p-pn	cr-pf	90.0R
Watertown	sgcp-pn	cd-pf	32.7B
Watervliet	srgm	md	15.0B
White Plains	sargc-ppy	cd	22.5B
Yonkers	sgmp-pn	mi-pf	99.8I
NORTH CAROLINA			
Asheville	sargm-pn	mi	25.0I
Charlotte			
Concord			
Durham	sargmp-pn	mi-pf	26.2I
Elizabeth City			
Greensboro	No	pf	21.9I
High Point	No	pf	14.0F
New Bern	srgm	md	15.0B
Raleigh	sgm	md	25.0B
Rocky Mount			
Wilmington	sgmp-pn	mf-pf	30.0I
Winston-Salem	srgmp-pn	mi-pf	55.0I
NORTH DAKOTA			
Fargo	sgm	mi	17.3I
Grand Forks	srgcp-pn	ci-pi	26.5I
OHIO			
Akron	agc23p-ppn	cr-pf	150.0R
Alliance	agc21p-ppn	cf-pf	22.0F
Ashtabula	srgc21p-ppn	cd-pf	23.0B
Barberton	agc18-ppy	cd	18.0B
Bellaire	No	pd	15.0B
Bellefontaine			
Bucyrus	sgmp-pn	mf-pf	11.1F
Cambridge	sgp-pn	pf	15.8F
Canton	sgmp-pn	mcr-pd	70.0R
Chillicothe	sargmp-pn	md-pf	17.0B
Cincinnati	agc-18-ppn	cr-pf	415.0R
Cleveland	sgm-pn	mr-pr-pf	750.0R
Columbus	sgmp-ppn	mr-pf	220.0R
Conneaut	No	pd	9.0B
Coshocton	sgc-18	cd-pf	11.6B
Dayton	sgmp-ppn	mr-pf	135.0R
Delaware	No		9.8F
East Cleveland	agc18p-pn	cf	16.0F
East Liverpool			
Elyria	sgc	cr	20.0R
Findlay	No	pf	17.0F
Fostoria	sgc18-pn	cd	12.0B
Fremont	sgc20-ppy	cf	11.8F
Hamilton			
Ironton	sargmp-pn	md-pf	16.0B
Lakewood	sgmp-pn	msf	22.6F
Lancaster	No	pd	15.7B
Lima	sgcp-pn	cd-pf	32.0B

	Collection*	Disposal†	Population‡
Lorain	sgc-21	cr	54.0
Mansfield	sgc21p-pn	ci-pr	25.0I
Marietta	No	pf	14.8F
Marion	No	pf	27.5F
Martin's Ferry	srgc-ppy	cd	12.1B
Massillon	No	pd	17.0B
Middletown			
Mt. Vernon			
New Philadelphia	No	pf	10.5F
Newark	sargcp-pn	cd-pd	32.9B
Niles	sargcp	cdp	12.0B
Norwood	sgm-pn	md	25.0B
Piqua	No	pf	14.5F
Portsmouth	sargm-pn	md	33.0B
Salem	No	pd	11.0B
Sandusky	srgcp	cd-pd	23.0B
Springfield	sgcp-pn	cf-pf	60.9F
Steubenville	srgc18p-pn	mi	29.1I
Tiffin	agc18p-pn	ci-pi	13.5F
Toledo	sgm-ppy	mcr	275.0R
Warren			
Xenia	No	pf	10.0F
Youngstown	agc18p-ppn	cr-pf	120.0R
Zanesville	sgm	mi	30.9B
OKLAHOMA			
Ardmore			
Chickasha			
Enid	No	pd	18.9B
Guthrie			12.0F
McAlester	No	pd	15.0B
Muskogee	srgc32-ppy	cf	44.0F
Okla. City	sgmp-ppn	mscf-pf	100.0F
Sapulpa	sgcp-pn	cf-pf	11.0F
Shawnee	srgmp-ppn	m-sf-pf	18.2F
Tulsa	sgc	cf	69.2F
OREGON			
Astoria	sgc-18p-ppn	cf-pf	20.0F
Eugene	No		13.6F
Medford	No	pf	14.1F
Portland			
Salem	No	pf	14.0F
PENNSYLVANIA			
Allentown	agc19p-pn	ci-pf	
Altoona	sgm-ppy	mcf	60.1F
Beaver Falls	sgm-ppy	mi	12.8I
Bethlehem	srgp-pn	pd	21.0B
Braddock	agc18-pn	cr	22.0R
Bradford	sgp	pf	16.0F
Bristol	sgc-ppy	cf	12.0F
Butler	sgcp-pn	cb-pf	28.1B
Carbondale	No	pd-pf	20.0B
Carlisle	No	pf	10.8F
Carnegie	srgc19p-pn	cb-pf	11.7B
Chambersburg	sargp-pn	pd-pf	13.0B
Charleroi			
Chester	sgc-ppy	cf	70.0F
Coatesville	sgc-ppy	cd	20.0B
Columbia			
Connellsville	srgc20-ppy	cf-ci	15.5F
Dickson City	No	pf	12.1F
Donora			
Duboistown	srgmp-ppyn	mi-pf	15.0I
Dunmore	No	pf	22.6F
Duquesne			
Easton	srgmp-pn	mf	30.9F
Edwardsville			
Erie	sgmp-pn	mi-pf	95.0I
Farrell			
Franklin	srgp	pb	10.7B
Greater Punxsutawney	No	pd	12.0B
Greensburg	sargp-pn	pb	16.0B
Harrisburg	sgc-ppy	cf	72.0F
Hazleton			
Homestead	srgm-ppy	mi	23.3I
Jeannette	No	pb	10.0B
Johnstown	No	pmi	82.0I
Lancaster	agc18p	cf-pf	50.0F
Lansford			
Larksville			
Latrobe			
Lebanon	No	pd-pf	22.0R
Lewistown	No	pd	11.1B
McKees Rocks	sgcp-pn	cb-pf	21.0B
McKeesport	srgmp-ppn	mi	55.1I
Mahanoy City	srgc18p-pn	cd-pd	18.4B
Meadville	srgc-ppy	cmi	15.0I
Monessen	sargmp-pn	md	17.5B
Mount Carmel			
Nanticoke			
New Brighton			
New Castle	sgmp-pn	mi-po	44.3I
Norristown			
North Braddock	sgm-pn	mi	26.8I
Northampton			
Oil City	srgc22p-pn	ci-pi	19.9I
Old Forge	No	pf	13.0F
Olyphant			
Philadelphia	agc18p-pn	cr-pf	1,800.0R
Phoenixville			
Pittsburgh	sgc-ppy	cr	590.0R
Pittston	No	pd	19.3B
Plymouth	No	pd-pf	19.1B
Pottstown	No	pf	20.0F
Pottsville	sargp-pn	pd	24.0B
Reading	sgmp-pn	mi-pf	117.0I
Scranton	srgmp-pn	mi-pf	154.3I
Shamokin			

	Collection*	Disposal†	Population‡
Sharon	sgc-ppy	cd	35.4B
Sharpsburg	sgc-ppy	cr	10.6R
Shenandoah			
S. Bethlehem	srgmp-pn	md-pf	30.0B
Steelton			
Sunbury			
Tamaqua	No	pd	10.8B
Taylor	No	pd	12.6B
Titusville	No	pd-pf	8.5B
Uniontown	sgc23-ppy	cf	20.8F
Warren	srgp-pn	pci-pf	14.4I
Washington	srgc19-ppy	ci	21.6I
West Chester	sgc19p-pn	cf-pf	13.1F
Wilkes-Barre			
Wilkinsburg	sgc18-ppy	cr	25.0R
Williamsport			
Windber			
York	sgc	cr	51.6R
RHODE ISLAND			
Bristol	No	pf	13.3F
Central Falls	sgc-ppy	cf	25.0F
Cranston	No	pf	29.3F
Cumberland	No	pf	10.8F
E. Providence	sgc20p-ppn	cf-pf	18.6F
Lincoln	sgc18p-pn	cf-pf	10.4F
Newport	sgc19-pn	cd	35.0B
Pawtucket	sgc18p-pn	cdf-pf	59.4F
Providence	sgc18p-ppyn	cf-pf	259.0F
Warwick	No	pd-pf	30.0B
Westerly	No	pf	9.4F
Woonsocket	No	pf	34.0F
SOUTH CAROLINA			
Anderson	sgm-pn	mi	13.0I
Charleston	sargmp-pn	md-p	60.7B
Columbia	sargmp-pn	md-pf	37.0B
Greenville	sargmp-pn	mi-pf	27.6I
Spartansburg			
Sumter	srgm-pn	md	9.2B
SOUTH DAKOTA			
Aberdeen	srgmp-pn	mb-pr	16.4B
Lead	sargc18p-pn	cd-pf	8.8B
Sioux Falls	No	pf	24.0F
TENNESSEE			
Chattanooga	sargmp-pn	md-pf	65.0B
Clarkesville	No		
Jackson	srgmp-ppn	mi-pf	18.0I
Johnson City	srgmp-pn	md-pf	12.9B
Knoxville	srgmp-pn	md-pf	36.0B
Memphis	srgmp-ppn	mi-pr-pf	151.3I
Nashville	sgmp-pn	mgf-pf	133.1F
TEXAS			
Abilene	sgp-pn	pf	14.0F
Amarillo			
Austin	sgp	pf	34.8F
Beaumont	srgm-ppy	md	33.0B
Brownsville			
Cleburne	No	pf	12.3F
Corpus Christi	srgmp-pn	mi	20.0I
Corsicana	No	pf	14.0F
Dallas	srgm-pn	md-pf	122.0B
Denison	No	pf	22.9F
El Paso	srgmp-pn	mi-pf	77.0I
Ft. Worth	srgc18p-ppn	cf-pf	109.3F
Galveston	srgmp-pn	mi	53.3I
Greenville	srgm-pn	mi	12.1I
Houston	sargcp-ppyn	ci-cd-pf	147.0I
Laredo	srgc18p-pn	cd-pf	42.0B
Marshall	No	pf	16.0F
Palestine	No	pf	12.5F
Paris	No	pf	14.0F
San Angelo	No	pf	16.3F
San Antonio	srgm	mi-pf	123.8I
Sherman	No	pf	16.7F
Temple	No	pf	17.0I
Texarkana	No		12.8B
Tyler	No	pf	15.0F
Waco			
Wichita Falls	sgm	mi	16.0I
UTAH			
Ogd..n	No	pci and d	44.7I
Provo	No	pf	10.6F
Salt Lake City	srgcp-pn	cf-pf	125.0F
VERMONT			
Barre			
Bennington	No	pf	9.1F
Burlington	srgc-ppy	cf	23.5F
Rutland			
St. Johnsbury	No	pf	8.8F
VIRGINIA			
Alexandria	No		17.8F
Danville	sargmp-pn	md-pf	21.5B
Lynchburg	srgm	mi	35.0I
Newport News	sagm-pn	md	55.0B
Norfolk	srgmp-ppn	mi-pf	106.2I
Petersburg	sargm-pn	mi	39.1I
Portsmouth	srgmp-ppny	mi	43.2I
Richmond	sgmp-pn	mi-pf	158.7I
Roanoke	srgmp-pn	mi-pf	45.7I
Staunton	sargmp-pn	md-pf	11.5B
WASHINGTON			
Aberdeen	sgcp-pn	cd-pf	22.0B
Bellingham			
Everett			
Hoquiam	Yes		11.7B
N. Yakima	sargmc-pn	md-pf	20.0B
Seattle	sargcp-pn	cd-pf	348.6B
Spokane	sargmp-ppyn	mi-pf	150.3I
Tacoma	sargc-pn	cd-pf	112.8B
Vancouver	No		
Walla Walla	sgcp	cf-pf	25.1F
WEST VIRGINIA			
Bluefield			
Charleston	No-m	mi-pf	15.4B
Clarksburg	No	mi	30.0I
Fairmont	srgmp-pn	mi-pf	12.8I
Huntington	srgm	md-pf	17.5I
Martinsburg	sargc18p-pn	cd-pf	50.0B
Morgantown	No	pf	13.3B
Moundsville	sgc-ppyn	cd	13.7F
Parkersburg	sgcp-pn	cf-pf	10.2B
Wheeling	sgm-ppy	mi	23.0F
WISCONSIN			
Appleton	No	pf	43.7I
Ashland	No	pf	18.0F
Beloit	sgmp-pn	cf-pf	13.1F
Chippewa Falls	srgcp-pn	cf-pf	20.0F
Eau Claire	No	pf	10.0F
Fond du Lac	sargmp-pn	md-pf	20.0F
Green Bay	sgmp-pn	mgf-pf	20.5B
Janesville	sgcp-pn	pf	30.1F
Kenosha	sargmp-pn	md	14.5F
LaCrosse	sgmp	msf-pf	28.4B
Madison	sgm	msf	31.7F
Manitowoc			32.8F
Marinette	srgmp-pn	md-pf	13.0B
Merrill	sgmp-pn	mgf-pf-md	8.7F
Milwaukee	srgmp-pn	mi-pf	436.5I
Oshkosh	No	pd-pf	36.0B
Racine	srgmp-ppny	mi	50.0I
Sheboygan	srgmp-pn	mi	29.0I
Stevens Point	No	pd	11.7B
Superior	sgcp-pn	cd	47.0B
Watertown	sgp-pn	pd	9.1B
Waukesha	sgmp-pn	mf-pf	12.7F
Wausau	No	pd	19.2B
WYOMING			
Cheyenne	sagc18-ppy	cd	14.0B
Laramie	Collected by private parties	pf	8.3F
Sheridan	No		

Freight Handling by Tractors Found Economical

Tractor-Trailer System Replaces Hand Trucking and Reduces Costs at Large L. C. L. Freight Station in Chicago

USE of small tractors to handle trucks in the 43rd St. outbound freight station of the Chicago Junction Ry. was begun in 1914 and has been continued since that time. It results in reduction of cost of freight handling, with fewer men and greater facility of work. At this station less-than-carload freight received from wagons, motor trucks and trap cars is sorted and delivered to cars for shipment. The freight house is U-shaped in plan, 700 ft. long, with 12 tracks and two platforms. It is so operated that all hauls are short, and as the average is only 250 ft., it is thought that the tractors do not show so great an advantage as they would if the distance were greater. But the railway officials consider that for any distance greater than 250 ft. the tractor system is more economical than hand trucking.

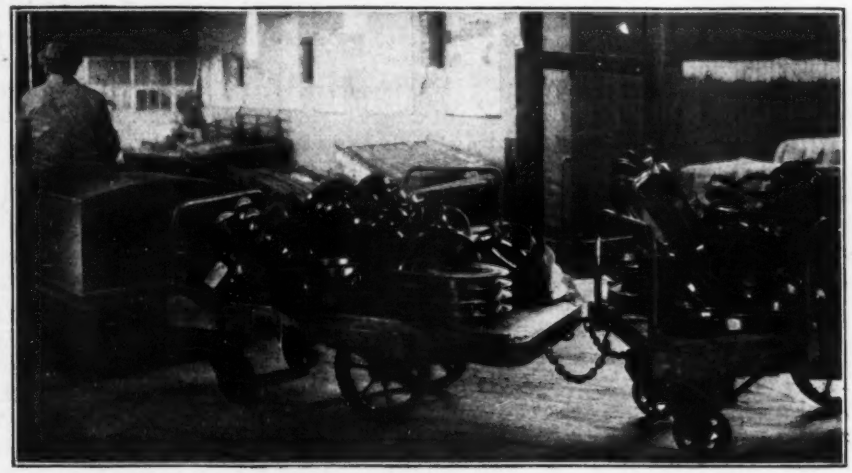
Electric storage-battery tractors are used. They weigh about 2100 lb. and are capable of running 12 hours on one charge. The tractors carry no freight, but haul trains of four-wheel trailer trucks. As many as 25 trucks can be hauled, but the average train consists of seven trucks. Sharp turns and corners are passed without difficulty, the trucks having castors for the front wheels and special couplings which insure every truck following in the path of the tractor. The average speed is three or four miles per hour, with loaded trains.

The tractor is kept continually on the move. It picks up loaded trucks at the team platform or the trap cars, and

ELECTRIC TRACTORS HAUL TRAINS OF AS MANY AS TWENTY-FIVE TRUCKS IN LARGE FREIGHT STATION AT CHICAGO

delivers them in succession at the outgoing cars. Having dropped all the trucks, the tractor returns for another train, picking up empty cars on its way. With each tractor there are a motorman and a helper. The latter couples and uncouples the trucks, uncoupling being done without stopping the train.

Freight is handled at the team platforms and trap cars by groups of four men, each assigned to a certain number of outbound cars. The checker indicates the car in which each package is to be placed and the caller marks it accordingly. The truckers place it on the truck destined for that car, and as the trucks are loaded they arrange them in the same order as the cars, so that they can be dropped consecutively by the tractor. At the cars there are dispatchers, each assigned to 150 ft. of platform. These take the trucks as they are cut off from the tractor train and push them to or into the car, ready for the stevedore who stows the freight. These dispatchers also remove the empty trucks and push them into position to be picked up by a returning tractor.



CASTOR FRONT WHEELS AND SPECIAL CHAIN COUPLINGS CAUSE TRAILER TRUCKS TO FOLLOW PATH OF TRACTOR

Two-wheel hand trucks are used to some extent, but are fitted with castors and couplings so that they can be handled as trailers if necessary. One four-wheel truck, however, will carry as much as five of the hand trucks. A special condition at this freight house is the necessity of handling about 20 carloads of perishable freight in one hour, at noon. The two-wheel hand trucks are used mainly during this rush hour.

Equipment and costs for the tractor-trailer system are shown by the accompanying table. The increase of about 1c. in cost per ton for 1917 as compared with 1914 is due to the change in wage rates and labor conditions. For 1917 the total labor cost of handling freight, including unloading from the wagon or trap car and stowage in the outgoing freight car, is stated to have been 35.6c. per ton, distributed as follows: Motormen, 1.4c.; supervision, 1.7c.; callers, 6c.; checkers, 7.3c.; truckers, 11c.; stevedores, 4.8c.; dispatchers, 3.4c. The cost of maintenance, repair, battery renewals and charging current averages $344.93 per tractor per year.

FREIGHT HANDLING BY TRACTOR-TRAILER SYSTEM AT CHICAGO STATION

	1914	1917
Number of tractors	2	4
Number of four-wheel trailer trucks	160	350
Number of two-wheel hand trucks	150	150
Tons of freight trucked daily	1,200	1,200 to 1,400
Average number of trucks per train	7	7
Maximum number of trucks per train	20	25
Average trucking haul	250 ft.	250 ft.
Cost of trucking by hand, cents per ton	16.27 to 17.37	15.8
Cost of trucking by tractor, cents per ton	12.57 to 13.30	14.4
Average saving by tractor, per ton	30%	30 to 35%
Wages:		
Checkers, per month	$75	$97
Callers, per hour	22½c.	29½c.
Truckers, per hour	22c.	28c.
Stevedores, per hour	23c.	29c.
Laborers, per hour	22c.	28c.
Motormen, per hour	23½c.	29½c.
Motormen's helpers, per hour	22c.	29c.

When this system was adopted it eliminated about 70 laborers formerly engaged in trucking. No change was made in the methods or men for unloading, sorting and stowing the freight. It is estimated that a return to the old system, assuming that the necessary number of men could be obtained, would cause a 50% increase in the present cost. E. O. Burton is agent in charge of the station. The work is done under the direction of W. J. O'Brien, general superintendent of the Chicago Junction Railway.

Character of Drawings Reflects Company Standards

Uniformity of Practice Is Necessary and Demands Attention to Details That by Themselves Seem Unimportant

By J. H. Melville
Assistant Engineer, Westinghouse Church Kerr & Co., New York City

WHILE a great deal of time and thought has been spent in standardizing drafting-room practice in the matter of design, the matter of the drafting itself, by which the design is to be expressed, has often not received the attention which is due to it. Character in drawings is no more than a standardization of principles for guidance in practice, and the character displayed measures the standards adopted by an engineering concern for the guidance of its drafting force.

An individual draftsman if left to his own devices may turn out an excellent drawing, but its characterization will be that of the individual. If we have a hundred draftsmen working under the same conditions, we may get a hundred excellent drawings, but we shall have such a mixture of characterization that it will not be at all pleasing or desirable as coming from the same company. Therefore, it is highly desirable for every engineering or architectural office that it should evolve in its drafting practice standards suitable to its particular class of work. In this way only can it acquire what we may call "company" character as opposed to "individual" character.

The following notes, while applicable more or less to all drawings, are intended to deal principally with working construction drawings, the chief function of which

is to provide clear and readable blueprints from which the construction forces may work with ease and certainty.

The first requisite of character in drawings would seem to be arrangement: that is, placing the different parts of the design on the sheet so that each will bring out the idea of the designer in a logical way, without the necessity of resorting to mental or optical gymnastics to find out what it is all about. In this connection it should be remembered that an overcrowded sheet cannot be clear, and clearness, next to accuracy, is the prime necessity in a working drawing.

Plans, sections and elevations should be placed as nearly as possible where they would be logically looked for. If a plan lies with its North toward the top of the sheet, it will be logical to look for a North elevation above it, a South elevation below it, an East elevation at its right and a West elevation at its left. For a section looking North the eye would also logically travel up or down and for sections looking East or West to the right or left. Of course it is not always possible to secure so ideal an arrangement, but the principle should be kept in mind. Sections, etc., should be placed somewhere near the place in which they would naturally be expected, or else be grouped together in some logical and easily found arrangement.

Handling of Details

A general plan on a small scale should not be cluttered up with details stuck in here and there. If the work is large enough, all details should be kept off the general plan and placed on a special sheet. With different sized standard sheets this is easily arranged without a waste of cloth; but if the work is unimportant, and it is desired to show details on the same sheet as the general plan, these should be collected on one part of the drawing—perhaps the bottom portion is best—and separated from the rest of the drawing by an inclosure line if it be thought necessary.

Though proper arrangement demands a little preliminary study and thought, this is amply repaid in the clearness of the drawing and the ease with which it may be read. Before a drawing is started the assistant in charge of the draftsmen should decide just what is to go on the sheet, and should have the various parts roughly blocked out to scale on the cloth with soft pencil for his approval. If he has a good sense of proportion and the fitness of things—as he should have—this will insure a good grouping of the various parts.

It will not be amiss at this point to mention two other matters, seemingly unimportant, but which, if neglected, are frequently enough to spoil the effect of a sheet. One occurs when the border lines should be drawn and the other is the common practice of pencil designing directly on the cloth. If the best arrangement is to be secured under all conditions, the border line should be the last thing put on the sheet—excepting only the title and "Notes," unless every part of the design is cut and dried and can be placed to a nicety before tracing. It is often a great advantage to be able to shift the border line an inch or two from the location first intended, to the great benefit of the appearance of the sheet.

One disadvantage in designing on cloth which outweighs its supposed advantages is that, after the design is drawn, it cannot be shifted, and must be inked in where it stands. Even with a carefully considered prearrangement of sheet, it often turns out that unforeseen additions or other modifications of design make it desirable to shift the position of some part from its original location, to secure better grouping of the various parts. Furthermore, it is very doubtful whether inking in a design made on cloth is any more quickly done than tracing from an independent sheet.

Legends and Lettering Deserve Careful Consideration

In arranging a sheet the "Notes," "Key," "Reference List of Drawings," and cardinal or "North" point must not be forgotten. It is well to standardize the location of these—of the first three at any rate. A good place for a "Key" and "Notes" is directly above the title, and for "Reference List of Drawings" directly to the left of same, or vice versa. The "Notes" generally contain essential specifications for the execution of the work, and it is highly desirable that the user of the plan should know where to find them and not have to hunt for them in a different part of each sheet. Ample space should be allowed to take care of extra notes or symbols that may be found necessary before the drawing is complete, and the "Notes," "Key," and "Reference List of Drawings" should not be put on till the drawing is finished. The size of lettering can be made to suit the space available, and it can be properly placed with respect to adjacent matter to avoid unnecessary crowding at one point and unnecessary blank cloth at another.

All drawings that show design in plan should have a "North" point. Especially is this desirable in a sheet of details such as the foundation details for isolated columns, and in such case every detail should bear its true relation to the "North" point.

The simple border consisting of two straight parallel lines—the inner one heavy and the outer or trim line lighter—meeting squarely at the corners, is now almost universal since it looks as well as any other and takes but little time to put on. Simplicity should also be the keynote of the "North" point and the linear scale. The latter is not generally used on any except topographical maps, or when plans are to be photographed. Size of "North" point and length in inches of linear scale should be standardized for different sized sheets, but the style should be kept uniform in all.

Lettering Should Be Standardized

Poor lettering can easily kill the best drawing ever made, and no other detail should be more carefully standardized. It is not the purpose to discuss here the relative merits of vertical or sloping lettering beyond venturing the opinion that vertical lettering, if properly done, is more in keeping with the vertical and horizontal lines that make up an engineering or architectural drawing. It is, however, very difficult to get it well done, and a much higher general standard of efficiency and speed can be obtained with sloping lettering. But whatever style is adopted it should be clear and bold with both capitals and italics of the same style. The attenuated affectations so much in favor with some architectural draftsmen, with elegantly modish Rs trying diffidently to forget their tails, should have no place in any system of lettering in an enginering office.

Standard heights of capital lettering should be fixed for different sized sheets, and no departure therefrom allowed on any regular working drawing turned out of the drafting room. Perspective sketches, or drawings made for illustrative or other special purposes, would of course be exceptions to the above rule, and should be treated as might seem most desirable in each case.

The lettering for the designations of "Plan," "Section," "Elevation," etc., should be in bold capitals, and reference lines to sections on plans should be boldly lettered so that they can be easily picked out. Nothing is more tantalizing than to find a reference line bashfully disguised with diminutive italic letters which cannot be distinguished from others around them. Structural steel draftsmen are frequent offenders in this respect.

The addition of a few words below the title of a section or plan telling its purpose will often save time, as for instance:

SECTION A-A.
Showing steam and exhaust headers.

PLAN AT ELEVATION 193'.
Showing crane runway and mezzanine landings.

And do not call a plan a section—it leads to a confusion. All plans are understood to be either sections or elevations on the horizontal plane, so it is clearer to apply the word "Section" to the vertical or intermediary planes only.

As a general rule, lettering should be done after all necessary dimensions and dimension lines are on the drawing, otherwise the two will often clash and make erasures of one or the other necessary. If a stamp is used, its design should be such that it will conform in the matter of lettering with the standards adopted. There are some stamps that detract from, rather than add to the character of a sheet.

Execution Is a Matter of Individual Talent

As to the execution of the drawing itself, this is a matter that must be left very largely to the talent of the individual draftsman. In the writer's opinion a very desirable reform in general drafting room practice would be a greater restriction in the use of diluted black ink. Working drawings require definition of line. Dilute ink is, at best, only an expedient which saves the draftsman the trouble of sharpening his pen while adding 100% to the perplexities of the construction forces. After a week or two of handling and erasures, the dilute-ink lines on a tracing become frayed and hazy; or have parts erased and never replaced, or else are replaced with ink a shade or two darker than the original mixture. The result is messy to look at and an invitation to errors. It certainly is not an aid to character in drawings. Whatever individual opinion on this matter may be, the point is that diluted ink should not be used when definition of line is important—such as for the center lines of columns and all others to which dimension lines refer. These at least should be in black.

Another practice, affected by some architects, which should be condemned is the overlapping of lines at angles. On perspective work or on full-sized details which have to be scaled this is perhaps permissible, but it certainly does not add to the character of a sheet of ¾-in. details to show walls and piers as if they were to be built "log-cabin" style.

If one expects to be taken seriously by those responsible for getting plans out to the field, it would not be safe in this busy age to pay more than a passing tribute to the value of shaded lines. They are a most valuable adjunct to the draftsman's art where the extra time can be afforded, and a great aid to clearness and character.

It may be said that the only thing that should not be standardized in the drafting room is the talent of the draftsman, but the method of expressing this talent must be governed by strictly enforced rules and standards if there is to be any uniformity of character in the drawings turned out. The enforcement of standard drafting practice lies largely in the hands of the assistant engineers and with them rests the maintenance of that standard of "company" character which is so desirable. It is a good plan—and also a paying one where the drafting force is more or less transient—to have in each squad a "retainer" or "old hand" who is thoroughly trained in the standards of the company, and paid well enough to make it worth his while to stay. He will be a valuable aid in breaking in new men and will save more than his extra salary in the maintenance of a high standard of excellence in the work of the drafting room.

In looking back upon the aids to character in drawings which have been touched on, it should be remembered that while the ideal and practical cannot always be reconciled, the closer we work to the ideal in practice the higher will be the resulting character attained.

Using Electric Power To Dredge a Relocated River Channel

Washington Counties Build Suction Dredge Operated by 800-Horsepower Motor Which Contractor Buys When Work Is Done

By J. H. Walter
Tacoma, Wash.

PRIOR to 1906 the main volume of the White River emptied into Elliott Bay at Seattle, except for a small portion of the flow, averaging about 500 sec.-ft., which left the main stream on an inland delta 40 miles from the mouth and flowed southward into the Puyallup River and thence into Puget Sound at Tacoma, a distance of 20 miles. This connecting link between the White and the Puyallup was known as the Stuck River. Topographical conditions on the inland delta were such that the shifting of a bar or an accumulation of drift would divert the river north or south over night. This did occur, in fact, in November, 1906, when high water conditions turned all of the White River through the Stuck Valley and thence to Tacoma by the Puyallup River.

King County desired to make this channel permanent by artificial means, but the situation was complicated by the fact that the King-Pierce County line passed near the point of diversion and only a short bend of the original channel was in King County. Pierce County authorities attempted to make King County take the river back and allow it to empty into Elliott Bay as before, but King County disclaimed all responsibility in the matter. Finally in 1913 the state legislature passed the inter-county river improvement act, providing for the establishment of funds to carry out the necessary work. A tax levy of one mill in Pierce County and

0.6 mill in King County provided $250,000 per year for six years, or a total of $1,500,000, for construction, with a maintenance fund to be $50,000 a year for 99 years.

It was decided that the entire flow would be conducted through the Stuck-Puyallup route to an outlet at Tacoma. The work to be done was accordingly classified under three heads: removal of drift, rectification of channels, and bank protection. The contract for channel rectification, which involved the excavation of 3,000,000 cu.yd. of earth, was let to the Puyallup Dredging Company. Under the terms of the contract the county supplied the company with an electrically operated dredge which the company agrees to purchase at 75% of its original cost of about $70,000 at the termination of the contract. During the work the municipal plant of Tacoma supplies current at the rate of 0.45 cents per kilowatt-hour.

Dredging Machinery

The hull of the dredge, which was built specially for this river work, is 115 ft. long, 40 ft. wide, and has a depth over all of 9½ ft. It is built with 10 x 12 bottom timbers and 10 x 18 bulkhead timbers and is designed so that all the machinery is located on deck and not inside the hull, thus making unnecessary recourse to trussing or framing. The longitudinal timbers are all long, and there are three interior cross bulkheads secured with 1-in. stay-bolts. The stanchions are 10 x 10-in. timbers and 10 x 10-in. deck beams, and 4 x 12-in. cross bracing was used to increase the rigidity. The hull is divided into ten watertight compartments with a separate compartment as water tank for the boiler. The hull involved the use of 170,000 ft.b.m. of lumber and 27,000 lb. of iron and steel.

The dredging equipment proper consists of a rotary cutter suction head and a 20-in. centrifugal pump with direct-connected motor. The digging ladder is built up of 24 in., 100 lb. I-beams, 52 ft. long. The cutter-shaft bearings, which are set on top of the ladder, are of standard pattern with the exception of the one forward and an outboard bearing in the suction head. These have cast-iron glands in place of babbitt, to allow for the excessive wear on account of grit, and to permit of quick and economical renewals. In these two bearings the cutter shaft is provided with cast-steel sleeves.

The cutter was originally of the helmet type, but has been replaced with a straight-blade cutter on account of encountering very hard clay strata. The cutter motor is mounted on a framed base in the port tongue of the ladder well and transmits its power through the port trunnion on a 60 to 1 reduction. The suction pipe, which is of cast iron, 20 in. diameter, passes from the cutter head up the digging ladder and through the starboard trunnion. The clearance provided in the trunnions is such that the weaving of the ladder when snags are encountered does not affect either the suction pipe or the cutter transmission.

The bull wheel on the cutter shaft is 86 in. in diameter and has an 8-in. face. Special thrust collars are provided for the end thrust of the cutter shaft. The suction head carries a back ring for the cutter, 6 ft. in diameter. The swinging plates are located far enough back from the cutter to keep the swinging blocks free from sand and grit. The cutter shaft, 8 in. in diameter, is of three parts connected by standard couplings.

The pump itself is a 20-in. centrifugal, with front and back lining and a renewable nose ring and stuffing-box. The pump-shell and runner are high carbon annealed-steel castings; the front and back heads are medium steel castings and the nose ring of cast iron, while the liners are one piece of plate steel. The runner shaft is hammered steel, 9 in. in diameter, with one oil ring bearing. The pump casing, together with these three bearings, is assembled on a cast steel base, with a structural sub-base between this and the structural bed. This bed is built up of six 12-in. I-beams running the full length of the unit and plated top and bottom with ½ in. steel. The bed sets directly upon and centers the five center bulkheads of the hull to which it is bolted. This construction has been so carefully installed and fitted that there is not the least vibration when the unit is running full capacity.

The suction and discharge pipes, 20 in. in diameter, are of cast iron ⅜ in. thick and have flange connections. Immediately behind the pump in the discharge line is a 20-in. cast steel flap valve to control the back flow when the pump is shut down. This is designed with a renewable valve seat and an unobstructed passage for material, and is fitted with an outside hand lever and counterweight.

The dredge is held in position by two steel-shot stern spuds, 50 ft. long, in cast steel wells 14 ft. apart. The leads to the spuds run direct from the head block on the spud tower to the drums of the winding machinery.

Electrical Equipment

The dredging pump is driven by a direct-connected 800-hp., 3-phase, 2200-volt motor, operated at 360 r.p.m. (synchronous speed). The motor is designed for continuous operation at any speed from 33⅓% reduction to full speed, and for two hours when developing 25% overload, or for 50% momentary overload, without undue strains or overheating. The cutter motor is likewise operated at 2200 volts, is rated at 75 hp. for 600 r.p.m. (synchronous speed), and is similar to the motor which drives the winding machinery. Both of the latter are reversible induction motors and allow continuous operation for two hours at 25% overload.

While the cutter and winding machine motors have standard drum type controls, the pump motor is equipped with contactor panel and master control. The resistance grids for the latter are mounted in a well ventilated house abaft the pilot house and atop the main deck structure. All controls, including the levers operating the various drums of the winding machinery, together with the three motors, are in the pilot house forward. The switchboards are made up as follows:

Panel No. 1—Incoming Line
Panel No. 2—800 Hp. Induction Motor
Panel No. 3—75 Hp. Induction Motor
Panel No. 4—75 Hp. Induction Motor
Panel No. 5—Lighting and Small Power

The pilot house also contains the digging gages and graduated dummy gage connected to the ladder to indicate the depth of cutter and vacuum, pressure and steam gages.

The winding machinery has an auxiliary double 10 x 12 steam engine, with movable coupling to line shaft. This arrangement permits of the use of the winding machinery irrespective of electrical power.

The boiler is kept constantly under a full head of

steam and the engine is limbered up every day. Steam is supplied at 120 lb. by a Clyde type boiler located on the main deck at the stern and jacketed with 2-in. asbestos blocks. Steam is also supplied to a 4-in. ejector for priming the main dredging pump and to a 12 x 7 x 12 in. pump which is used for handling the bilge and can be used for fire service. This pump is so connected that water can be drawn through a 6-in. line from any of the ten water-tight compartments or from outboard. There are four 2-in. fire hydrants on the dredge which are fed through a throttling valve so that any desired pressure can be secured. A 2-in. relief valve on this line affords safety against overpressure.

With the dredge there were furnished 12 pontoons, 500 ft. of 7-gage riveted pipe with dredging sleeves, 3000 ft. of 10-gage riveted levee pipe and the necessary couplings. The pontoons are 12 x 24 ft. in plan, 2½ ft. in depth, and four of them are equipped with turntables so that the obstruction to cross currents can be reduced to a minimum. It was found advisable to build a derrick scow as a dredge tender. This scow is 26 x 48 ft. in plan and is equipped with a 9 x 10-in. 3-drum hoisting engine and a stiffleg derrick with a 40-ft. boom. This scow is used in removing drift and snags from the channel and for general repair work around the dredge.

In a test run made to determine the efficiency of the pump unit, a 3000-ft. length of discharge line was laid so as to obtain 25 ft. difference in elevation between the end of the discharge and the surface of the water at the dredge. Owing to the fact that a uniform formation was seldom encountered while digging, only a clear water test was made, and thus a more even result was obtained. The velocities were obtained by placing 6-in. wooden balls in the suction pipe and measuring the time of transit to the end of the discharge. Also, 1-gal. jugs of potassium permanganate were used, the jug breaking in the pump and coloring the water. Fairly uniform results were secured in eighteen trials.

The vacuum pressure and power consumption ratings were taken at intervals of one hour or less over a period of 19 hours steady running. The only difficulty encountered was in holding the land pipe together, and this arose from the fact that the line was put together hurriedly. As only clear water was pumped there was no silt to close up the joints. The results were:

Average pressure = 43 lb. =	98.9 ft. head
Average vacuum = 19 in. =	21.5 ft. head
Total	120.4

Velocity as measured = 15.3 ft. per second.

Therefore

$$\frac{15.3 \times 2.18 \times 62.5 \times 120.4}{550} = 456.3\text{-hp. output}$$

Power consumed = 505.8 kw.-hr. = 678 hp. input.

$$\frac{456.3}{678.0} = 67.3\% \text{ efficiency of unit}$$

Taking motor efficiency to be 90%

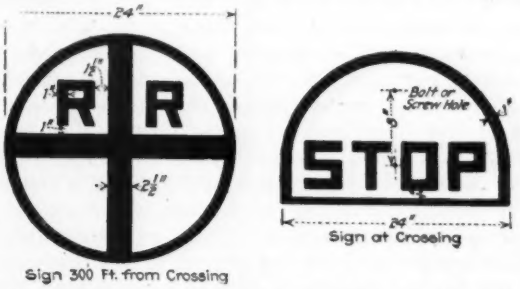
$$\frac{67.3}{90} = 75\% \text{ efficiency of pump}$$

W. J. Roberts, M. Am. Soc. C. E., is chief engineer of the Inter-County River Improvement. The writer, as principal engineer, designed the dredge and equipment, supervised its construction, and operated the outfit for sixty days, at which time it was turned over to the Puyallup Dredging Company.

New Grade Crossing Signs Required on Illinois Highways

PROTECTION of highway traffic at dangerous railroad crossings by special road signs is ordered by the Public Utilities Commission of Illinois. Local highway commissioners must place approach or distance warning signs 300 ft. from the crossings, in addition to the signs placed on the right-of-way by the railways.

Signs placed directly at the crossings are often inadequate, it is pointed out, as warnings for fast motor vehicles or even for ordinary traffic, where the view is obstructed by grades, curves, cuts or trees. Distant signs have been advocated, but the railways had no



ILLINOIS ORDERS SPECIAL ROAD SIGNS FOR DANGEROUS GRADE CROSSINGS

authority to place them outside their own property, and local highway authorities have given the matter little attention. Under the new order grade crossings designated as "extra hazardous" by the commission must be provided with two signs on each approach.

At 300 ft. from the crossing the highway commissioners must place a 24-in. circular sign, while the railway must place at the crossing a semicircular "stop" sign. These are to be of the style and dimensions shown in the illustration. They are of No. 16 sheet iron, porcelain-enameled in black and white, having the edge crimped and having holes for attachment to a post. The letters are 5 x 3¾ in., made with 1-in. lines, while the cross lines are 2½ in. wide and the border is 1 in. wide. The reverse side is black. These signs are fastened to iron posts by bolts or to wood posts by brass screws, the posts being so designed as to permit the attachment of a bracket for a light at night, when this is considered necessary by the commission.

Dump Refuse to Form Chicago Park

Use of street sweepings, ashes, factory waste, refuse and wreckage from old buildings, as filling for park land on a submerged site, is advocated by the Chicago Association of Commerce as a means of forming the new lake-front park that is to connect Grant and Jackson Parks. In this distance of nearly five miles about 1280 acres are to be reclaimed. It is estimated that the city produces about 3,000,000 cu.yd. of waste annually, and that by systematic and universal disposal on the lake front this will effect the reclamation of about 100 acres per year. A charge for dumping privileges is proposed to help pay the cost of the necessary retaining walls and bulkheads on the boundaries of the site. The present Grant Park is located on land reclaimed in the same way some years ago.

ENGINEERING LITERATURE

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Worthy Addition to Engineers' Handbook

MINING ENGINEERS' HANDBOOK: Written by a Staff of Specialists Under the Editorship of Robert Peele, Professor of Mining Engineering in the School of Mines, Columbia University. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Leather; 4 x 7 in.; pp. 2307; illustrated. $5.

President Eliot's five-foot book shelf would scarcely hold the best of the handbooks for engineers and allied technical men which have been published in original or revised editions in the past dozen years. The latest addition to the list is designed to serve the needs of the mining engineer. The amount of material which it contains on civil, mechanical and electrical engineering subjects illustrates how the various engineering fields overlap one another. Although the volume extends to almost 2400 pages, metallurgical engineering is treated rather sketchily, and but small space is given to coal mining. The preface explains that a companion handbook on metallurgy is in contemplation, and that there is a coal-mining pocketbook already in existence. The preface, speaking of the fact that there are already two mining engineers' handbooks, remarks that these "either omit, or treat too briefly, many subjects which constitute important parts of the professional equipment of the present-day mining engineer."

The breadth of treatment in the handbook before us may be indicated by stating that, aside from what one might expect to find, it contains sections on mine organization and accounts, wages and welfare, and mining laws, besides one dealing with mine air, hygiene, explosions and other accidents, this last being by George S. Rice, chief mining engineer of the United States Bureau of Mines.

As a rule, each of the 44 sections of the handbook has been contributed by a different specialist. Sections of the greatest interest to the readers of this journal, with their authors, taken in the order of their appearance in the volume, are as follows: Earth excavation and also rock excavation, H. P. Gillette; tunneling, D. W. Brunton and John A. Davis; shaft sinking in rock, Homer L. Carr, and in soft water-bearing soils, Francis Donaldson; boring, Prof. Arthur F. Taggart; underground transport, Edward C. Holden; hoisting plants, etc., Prof. William M. Weigel; drainage, Robert Van Arsdale Norris; mine ventilation, S. E. Brackett; compressed-air plants, Richard T. Dana; electric power for mine service, George R. Woods; surveying, Prof. Charles B. Breed, and underground surveying, Prof. Edward K. Judd; mine geologic maps and models, R. A. Sales; cost of mining, J. R. Finlay; preparation and storage of anthracite coal, Paul Sterling; hydraulics, Prof. J. K. Finch. There are also sections on thermodynamics, steam engines and related subjects, mechanical and electrical engineering, and structural design.

A valuable feature of the handbook is the bibliographies given in connection with each section, some f which run to hundreds of entries.

Two misleading statements in the section on wages and welfare may be mentioned. It is said that for purposes of water coagulation one grain of alum per gallon is used. From this it might be inferred that no more and no less was ever employed. Under sewage disposal it is stated that "Septic Treatment" involves two steps: (a) Putrefaction and (b) nitrification—which is a scientific contradiction. The context, however, makes it clear to those who pay sufficiently close attention that the author is really discussing not septic treatment alone, but that process followed by some method of oxidation. These examples merely illustrate the difficulties of obtaining accuracy and completeness in a handbook of such broad scope as this one. To insure accuracy in all the numerous details presented would require the services of hundreds instead of two-score specialists. Whether it is wise to attempt to go into so many details in various branches of engineering in a handbook designed to cover one branch, is a question regarding which much might be written on both sides. But whatever might be said either way, the fact remains that the present volume is a worthy addition to engineering handbooks and deserves a place in the reference libraries of many civil, electrical and mechanical engineers. That every mining engineer will desire a copy seems beyond question.

Contractors' Business Methods

ETHICS OF CONTRACTING AND THE STABILIZING OF PROFITS—By F. W. Lord. Garden City, N. Y.: The Country Life Press. Cloth; 5 x 7 in.; pp. 184. $1.25.

MODERN MANAGEMENT APPLIED TO CONSTRUCTION—By Daniel J. Hauer, Construction Economist; Consulting Engineer. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd. Cloth; 6 x 9 in.; pp. 187; illustrated. $2.50.

Two new books which are well worth, to every contractor, the time required to study them are listed above. Both treat of the business and management side of contracting, but Mr. Lord's work concerns the relations of the contractor with the world outside his own organization, while Mr. Hauer's deals with modern management as applied to the organization of the contracting business itself. Both books are written from the new, progressive point of view which is rapidly gaining favor under modern conditions. Both outline methods which were openly scouted when first proposed not many years ago.

Mr. Lord is an ardent advocate of the open price association. His book is addressed largely to the subcontractor, who is naturally the one in a position to benefit most quickly by the adoption of open price methods. He presents a strong argument for the local association of contractors and analyzes the manner in which various common evils can be eliminated under the open-price plan.

Mr. Hauer studies scientific management, as applied to construction work, from a very broad viewpoint. He gives the human engineering factor the place to which it is entitled, and which it is coming to occupy in the minds of some of the best administrators in contract-

ing. The entire work endeavors to set before the contractor the ways in which an intelligent, efficient and loyal organization can be built up. The skilled and unskilled workmen are by no means eliminated from consideration in this organization. Only a part of this scheme is represented by scientific management, as popularly understood when time and motion studies and the advance planning of manufacturing or construction operations are discussed. The larger part of it lies in the matter of inducing the human organization to put its best efforts continuously into the work according to well-directed plans, by making sure, through a large number of available means, that this element has cause to set a high value on its position in the business and to consider itself a part of the enterprise.

Both books will give contractors who have not considered these problems a profitable viewpoint. Both outline questions which have a fundamental bearing on the efficiency and therefore on the success of contracting as a business. The time is coming when no contracting business can realize large success without applying these principles, and every contractor who wishes to insure the future of his own enterprise will begin to study them and apply them in his own relations.

Textbook on Heating and Ventilation

HEATING AND VENTILATION—By John R. Allen, Dean of the Department of Engineering and Architecture, University of Minnesota, M. Am. Soc. M. E., and J. H. Walker, Superintendent of Central Heating, The Detroit Edison Company. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd. Cloth; 6 x 9 in.; pp. 265. Illustrated. $3.

REVIEWED BY D. D. KIMBALL
New York City

Primarily designed "as a textbook upon the subject of heating and ventilation for use in the engineering and architectural schools," as the author states in his preface, this volume, including as it does working methods of design and various tables and charts, will be "of some value as a handbook for the practicing engineer and architect," it is believed. In the first of these aims the author appears to have succeeded. In fact, it seems to the reviewer that the book is better suited for use as a college text than any other which has yet appeared on the subject.

The author seems to appreciate the difficulty of thoroughly presenting the subject of heating and ventilation within the time usually assigned to the subject in a college course. The ground is covered in a most practical and condensed manner. The problems presented for solution at the end of most of the chapters are an admirable feature of the book, but the present writer would suggest that answers should be provided in future editions. The data tables and illustrations are good, although limited. Certain subjects, such as "Dust and Fume Removal," are too briefly treated, but this may be due to the insufficient consideration which has been given to them by ventilating engineers.

As regards the second object, the book appears to be too condensed and incomplete to serve the needs of architects and engineers in practice. The fundamentals of heating and ventilation are well rounded out, but the student who has mastered these would require more information in practice than the book contains. Some of the standards presented were established by recognized authorities of past years, but have been materially modified by engineers in more recent practice; for instance, the percentage by which radiation is increased for buildings intermittently heated. A limited number of modifications of the text would largely improve it for the use of practicing engineers. On the whole, the authors and publishers are to be congratulated on the production of so good a book.

Dr. Houston on Rural Water-Supplies

RURAL WATER SUPPLIES AND THEIR PURIFICATION—By Alexander Cruikshank Houston, M. B., D. Sc., F. R. S. Ed., Director of Water Examination, Metropolitan Water Board. London: John Bale, Sons & Danielsson, Ltd. Cloth; 6 x 9 in.; pp. 128; illustrated. 7 shillings 6 pence net.

Anything from Dr. Houston on the potability or treatment of water-supplies is sure to be welcomed by water engineers and sanitarians who know of his long and valuable researches on the water-supply of London. His annual reports on those studies are veritable classics. Besides these he has written two books, "Studies in Water-Supply" and "Rivers as Sources of Water-Supply," noticed in these columns Apr. 16, 1914, and Jan. 17, 1918.

In the present volume the author has aimed to "fulfill a want which has long been felt by rural dwellers" for a safe guide in solving the water-supply problems which confront them. The first three chapters deal with rain water, and also describe briefly "the chief methods for sterilizing and purifying water," including the author's excess-lime method. Underground and surface waters are next considered, after which three chapters are devoted to the results of experiments and to the description of apparatus designed to treat household supplies. The volume closes with miscellaneous data on water treatment.

The volume seems better suited to scientists, professional and amateur, and country gentlemen with abundant leisure, than to laymen, but it contains enough of plain instruction to put any intelligent layman on the right track. Moreover, the author generously volunteers to assist perplexed readers of his book in the solution of their problems.

How to Save Fuel in Power Plants

FUEL ECONOMY IN BOILER ROOMS: A Development of Fuel Economy and CO_2 Recorders; Published in the Engineers' Study Course from "Power." In Two Parts: Part I: Fuel Economy and CO_2 Recorders—By A. R. Maujer and Charles H. Bromley of the Editorial Staff of "Power"; Part II: Fuel Economy in Boiler Rooms—By Charles H. Bromley, Associate Editor of "Power." Second Edition. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd. Cloth; 6 x 9 in.; pp. 302; illustrated. $2.50.

Timeliness marks this new and much enlarged edition of a volume designed to save fuel in power plants. If such a volume was needed in 1914, as unquestionably it was, it is needed many times more in 1918, and particularly so just now, as winter power-plant problems are upon the country in war time.

Published first under the title of "Fuel Economy and CO_2 Recorders," the junior author has added to the present edition a section on "Fuel Economy in Boiler Rooms," and this section title has been adopted as the title for the whole book. The old and new matter taken together ranges over the whole field of power-plant operation in relation to fuel economy, including coal and oil as fuels and their combustion fuel and flue-gas analyses, draft and its management, chimney design,

evaporation, boiler-setting efficiency and ratings, heat balance, the CO_2 recorder and its use, burning fuel oil, and the operation of mechanical stokers.

The volume is said to be intended "primarily for the student, the fireman and power-plant operating engineer," but it is designed to be useful to the consulting engineer as well. Engineers of water-works pumping stations and superintendents of water-works should find the volume of material service.

Non-Bituminous Road Materials Bulletin

Typical specifications for non-bituminous road materials have been compiled and issued by the United States Department of Agriculture. The bulletin covers all kinds of road material which cannot be classified as bituminous, and is a companion bulletin to "Typical Specifications for Bituminous Road Materials." These bulletins cover practically every kind of road material, and, as their names imply, do not go into details of construction but merely give the proper specifications and tests for the materials themselves. However, footnotes mention to some extent the proper thickness and the construction conditions which will give the most satisfactory results.

Rural Sanitation and Housing

A report on "Sanitation of Rural Workmen's Areas, with Special Reference to Housing," fills 30 pages of *Public Health Reports* (Washington, D. C.) for Sept. 6. It was prepared by a committee of the National Council of Defence, having Prof. George M. Kober, Georgetown University, Washington, D. C., as chairman. Water-supply, sewage and garbage disposal were among the topics discussed.

Instructions for Highway Engineers

A new publication of the Wisconsin Highway Commission (Madison, Wis.) entitled "Instructions to Engineers," and compiled by Gordon S. Daggett, engineer of surveys and plans for the commission, contains instructions in regard to surveys, forms of records, form of reports, preparation of plans and many other things incident to a state highway system.

Wisconsin Highway System Map

Wisconsin main and secondary highways, various points of industrial, scenic and historic interest, including Indian mounds and village sites, are shown in a booklet and folding map compiled by A. R. Hirst, state highway engineer. (Superintendent Public Property, Madison, Wis.; 10c.)

PUBLICATIONS RECEIVED

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be obtained without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other persons indicated.]

AMERICAN CITIES: THEIR METHODS OF BUSINESS—By Arthur Benson Gilbert, M.A., Formerly with the Extension Division, State University of Iowa. New York: Macmillan Co. Cloth; 5 x 8 in.; pp. 234. $1.50.

ANNUAL CHEMICAL DIRECTORY OF THE UNITED STATES, 1918—Consulting Editor, F. B. Lovelace, Johns Hopkins University; Managing Editor, Charles G. Thomas. Second Edition. Baltimore, Md.: Williams & Wilkins Co. Cloth; 6 x 9 in.; pp. 534. $5.

ASSOCIATION OF ONTARIO LAND SURVEYORS: Proceedings, 1918—Ontario, Can.: The Association. Paper; 6 x 9 in.; pp. 228. Illustrated.

CONCRETE STONE MANUFACTURE—By Harvey Whipple, Managing Editor of "Concrete." Second Edition, Revised and Enlarged. Detroit, Mich.: Concrete-Cement Age Pub. Co. Cloth; 5 x 7 in.; pp. 320. Illustrated. $1.50.

DAILY RIVER STAGES AT RIVER GAGE STATIONS ON THE PRINCIPAL RIVERS OF THE UNITED STATES: Vol. XV, 1917—By Alfred J. Henry, Meteorologist. Washington, D. C.: U. S. Department of Agriculture. Paper; 9 x 12 in.; pp. 282.

THE DIESEL ENGINE: Its Fuels and Its Uses—By Herbert Haas. Washington, D. C.: Superintendent of Documents. Paper; 6 x 9 in.; pp. 130. Illustrated. 25c.

Types, details, kinds made by various manufacturers in the United States, fuels, oils, cost data, examples of successful use and a bibliography are presented. The illustrations include views, details and diagrams.

THE ENGINEER'S YEAR-BOOK FOR 1918—Compiled and Edited by H. R. Kempe, M. Inst. C. E., M. I. Mech. E., M. I. E. E. With the Collaboration of Eminent Specialists. London: Crosby Lockwood and Son. Leather; 5 x 7 in.; pp. 2098. Illustrated. $12.50.

Since its original issue, a quarter century ago, this work has been expanded from 1528 to 2098 pages. The list of associate editors and contributors contains about fifty names, from all branches of engineering. In the present issue there are new sections on fuels, mine valuation, metallurgy and explosives.

GEORGE WESTINGHOUSE: His Life and Achievements—By Francis E. Leupp. Boston, Mass.: Little, Brown & Co. Cloth; 6 x 9 in.; pp. 300. Illustrated. $3.

HANDBOOK OF MECHANICAL AND ELECTRICAL COST DATA: Giving Shipping Weights, Capacities, Outputs, and Net Prices of Machines and Apparatus, and Detailed Costs of Installation, Maintenance, Depreciation and Operation, Together with Many Principles and Data Relating to Engineering Economics—By Halbert P. Gillette, Consulting Engineer, M. Am. Soc. C. E., and Richard T. Dana, Consulting Engineer, M. Am. Soc. C. E. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd. Leather; 5 x 7 in.; pp. 1716. Illustrated. $6.

THE HISTORY OF STATISTICS: Their Development and Progress in Many Countries; In Memoirs to Commemorate the Seventy-fifth Anniversary of the American Statistical Association. Collected and Edited by John Koren. New York: Macmillan Co. Cloth; 6 x 9 in.; pp. 739. $7.50.

LOUISIANA BOARD OF STATE ENGINEERS: Report for 1916-18—New Orleans, La.: Board of State Engineers. Paper; 6 x 9 in.; pp. 133.

MINE TRACKS, THEIR LOCATION AND CONSTRUCTION: Treating Briefly on the Materials Used and the Principles Involved in the Design and Installation, With a Set of Rules for a Standard Practice—By J. McCrystle, E. M. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd. Leather; 5 x 8 in.; pp. 102. Illustrated. $1.50.

THE MOTOR TRUCK AS AN AID TO BUSINESS PROFITS—By S. V. Norton. Chicago, Ill.: A. W. Shaw Co. Cloth; 7 x 10 in.; pp. 498. Illustrated. $7.50.

PETROLEUM: A Resource Interpretation—By Chester G. Gilbert and Joseph E. Pogue, of the Division of Mineral Technology, United States National Museum. Washington, D. C.: Smithsonian Institution. Paper; 6 x 9 in.; pp. 76. Illustrated.

THE PRACTICABILITY OF ADOPTING STANDARDS OF QUALITY FOR WATER SUPPLIES—By Robert B. Morse and Abel Wolman. Reprinted from the "Journal" of the American Water-Works Association, Vol. V, No. 3, September, 1918. Address the Authors, Maryland State Board of Health, Baltimore, Md. Paper; 6 x 9 in.; pp. 30.

A PRELIMINARY ANALYSIS OF THE DEGREE AND NATURE OF BACTERIAL REMOVAL IN FILTRATION PLANTS—By Abel Wolman. Reprinted from the "Journal" of the American Water-Works Association, Vol. V, No. 3, September, 1918. Author, Maryland State Board of Health, Baltimore, Md. Paper; 6 x 9 in.; pp. 7. Illustrated.

REPORT ON THE BUILDING AND ORNAMENTAL STONES OF CANADA. Vol. V, Province of British Columbia—By William A. Parks, B.A., Ph.D. Ottawa, Can.: Department of Mines. Paper; 7 x 10 in.; pp. 224; illustrated.

RULE RELATING TO AUTOMATIC SPRINKLER SYSTEMS—(Not Applicable to the City of New York) Bulletin No. 20, Industrial Code; State of New York, Department of Labor, State Industrial Commission. New York: Bureau of Industrial Code. Paper; 6 x 9 in.; pp. 17.

STANDARDIZATION OF THE SAYBOLT UNIVERSAL VISCOSIMETER—By Winslow H. Herschel, Associate Physicist, Bureau of Standards. Washington, D. C.: Superintendent of Documents. Paper; 7 x 10 in.; pp. 25; illustrated. 10c.

WORKMEN'S COMPENSATION LAW, NEW YORK STATE: With Amendments, Additions and Annotations to July 1, 1918—Issued under the Direction of The Industrial Commission. John Mitchell, Chairman, Edward P. Lyon, Louis Wiard, James M. Lynch, Henry D. Sayer. Albany, N. Y.: Bureau of Statistics and Information. Paper; 6 x 9 in.; pp. 66.

SOCIETY SERVICE

A Section Dealing with the Results of Teamwork by Technical Men

Licensing Engineers in Iowa

The Waterloo Technical Society, Waterloo, Iowa, which held its first meeting of the season Sept. 20, is considering two lines of activity. One is following up the campaign in favor of state legislation for the licensing of engineers, which was begun in 1917; the other is the conservation of fuel, in line with the work of the United States Fuel Administration. S. J. Fairbanks is secretary of the society.

Columbus Engineers' Club to Learn of Local Industries

Visits to the plants and industries in Columbus, Ohio, to acquaint the membership of the Engineers' Club of the city with the city's activities are to be undertaken intensively by the club. The organization is coöperating with the local War Industries Board and has named Prof. W. T. Magruder as chairman of the engineering section. A committee has under consideration the indorsement of the proposal of the Cleveland Engineering Society, that membership in a local society shall be regarded by the national societies as a prerequisite to membership in the latter.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Engineering Profession Should Have Leading Part in Reconstruction

Sir—What should the engineer and the engineering society do to help solve reconstruction problems?

Engineers, individually and collectively, have done and are doing much to win the war. In fact, the great world war is largely a matter of engineering. The engineers have an equal or even greater duty in securing to mankind the benefits which flow from victory. They, as men of vision, educated largely at the public expense, have a responsibility and an opportunity surpassing that of other classes of citizens.

They may be excused for their lack of preparedness for war, because war was uncertain. But there is no excuse for failure to prepare for peace. Even though the United States may be merely entering the great war, and while we should devote every possible energy to winning it quickly, yet we know that peace must come some time, whether next year or the year after. We also know that the longer the war continues the greater will be the changes and the more the necessity for thorough preparedness for the resumption of peace activities.

Someone must have the foresight and vision to get ready for the rapid shift which will take place when peace is declared. There is no way of evading the changes. Shall we have any plans ready, or shall we simply leave matters to "muddle along" and take the consequences in internal upheaval and prolonged suffering?

If plans are to be made, shall the task be left to the commercial interests, to the bankers, to the lawyers or to the politicians? Does the engineer intend simply to keep hands off and as a passive spectator or disinterested citizen let matters take their own course? Or will he use his training and experience to conduct researches into the present conditions and rapidly to prepare plans consistent with his broad knowledge of existing conditions? These are momentous questions and should be seriously considered by each engineer and especially by the engineering societies.

It may be urged that consideration of after-the-war problems is premature, but our allies are not of this opinion. They have already begun careful study into the conditions which may prevail. Great Britain has a highly developed Ministry of Reconstruction, with many engineering committees or branches. Canada and other parts of the British Empire are following the example of the mother country. France also is making far-reaching plans, and throughout the world it may be said that every advanced country except the United States is considering the matter from the scientific and practical standpoint. Already bills have been introduced in our own Congress, but the great body of engineers has not yet been heard from.

It may be urged in reply that reconstruction is not the business of the engineer. A little consideration, however, will show that there are relatively few fundamentals with which he is not concerned. Of course, much depends upon what we mean by the engineer. If we limit our definition simply to the mechanician or to the man who is studying the materials of construction, then the excuse may be offered that his range of duties is somewhat limited. But if we adopt a more modern definition, one within which the engineer is acting more and more, then it appears that his responsibilities are large indeed.

Perhaps the best definition yet offered is that by C. C. Williams, of Kansas University, who has elaborated upon Tredgold's well-known saying as follows: "Engineering is the science, art, and business of utilizing the forces and materials of nature and the *abilities of men* to promote the welfare and prosperity of mankind."

If this definition is adopted and we compare it with the list of things which form the subjects of research and study in any reconstruction project, it is surprising to note how many of these fundamentals fall within the domain of the engineer. Primarily, under our new conception of things, the engineer is concerned with the greatest of all the forces used in engineering, that of man himself. Labor, which has before been considered merely as incidental, now occupies the front place in all engineering plans. Fully one-half, if not more, of the expenditures in engineering go directly for labor, and the efficiency and economy of all engineering operations are dependent directly upon the wise direction and control of the labor factors.

It thus appears that the first and foremost consideration in the modern engineer's mind is that of labor questions, and while any solution of these must be partial and temporary, yet even this cannot be workable unless the engineer has a large hand in it.

Next in importance is research and investigation into natural resources and laws. This is particularly the work of the scientific man and engineer, and without his intelligent direction little progress can be made. The great war has awakened American engineers to the fact that in their somewhat complacent attitude of mind they had permitted European nations, especially Germany, to outstrip them by far, with the result that when the war came suddenly upon us we were compelled to lose time, and directly or indirectly sacrifice thousands of lives and millions of dollars in accumulated wealth, because of our short-sighted policy with reference to scientific research along engineering lines.

The whole subject of raw materials is also one which can be attacked successfully only by the engineer, including among these materials not only iron, copper, clay, petroleums and other substances from the earth, but also the fuels and other sources of power, such as the flowing waters.

The engineer's problems also include those pertaining to transportation, not merely the building and operating of railroads, waterways and highways, and the cars or vessels moving on these, but also the navigation of the air and all of the matters which lead up to successful performance.

Next in importance come the means of communication—the telephone, the telegraph, the wireless—and closely connected with these are the rapidly increasing number of public utilities, founded primarily on engineering plans and methods. It has been the fashion to leave the larger control of these to business men and lawyers, but the time is arriving when the engineer is appreciated as the chief factor in their success.

Into agriculture also the engineer has entered, and with the increasing demand for food, his skill is being more and more called upon, not only in developing agricultural machinery, but in building irrigation and drainage systems, in clearing lands and in directing operations in a large way. In housing problems the engineer, as well as the architect, must direct affairs. Even in education and the diffusion of intelligence the operations are becoming more and more closely connected with the principles of engineering.

In all of these matters, which pertain to the conservation and use of the resources of the country, both material and human, and the development of ideals, the engineer should be the leader. Although his profession may not include the direct control of capital and credit, of foreign and domestic trade, of agricultural distribution, and of many purely business questions, yet he is, or should be, such a factor in the fundamentals of these that his knowledge and skill cannot safely be neglected.

Assuming that the above statements of the range of the engineer's activities are approximately correct, then comes the question as to what he and his organizations should do in the present crisis of world affairs. The reply seems obvious that of all mankind he should be most active in these world problems. Every engineering society should have its committee on reconstruction, charged with the duty of arranging for effective presentation of one or another of these great subjects—employment of labor, research, study of raw materials, of fuels, power, transportation, public utilities and other matters, all of which are undergoing radical changes. The trend of these should be studied and the influence of the engineer as an individual should be wisely used.

The engineering society under this conception has a great duty and responsibility to its members and through them to the public. The standing of the engineering profession in the near future must be determined largely by the wisdom of the action taken now in approaching these great problems of reconstruction.

ENGINEER.

Is the Old Academic Educational Program Passing?

Sir—A personal letter from a Middle West professor of engineering indicates that the academic educational shell of past days spoken of by Prof. Frederic Bass in *Engineering News-Record* of Sept. 26, p. 582, is cracking. The letter indicates that the teachers in the Middle West school only needed the magical touch of necessity and practicability to start them on the way toward new methods. The letter follows:

"The new Government orders in regard to technical and college education have come, and I have been appointed chairman of the committee to devise a new curriculum to meet the new conditions. There will be a grand rush by all the colleges to get competent instructors and there will be mighty few to get.

"The head of the department of mathematics has been working out an entirely new method of teaching that subject. He is going to present the concrete side, rather than the abstract. Physics, including statics and dynamics, simple phenomena of heat and electricity, will be presented immediately to the freshmen with everyday illustrations; the students will absorb mathematical processes before they realize what is happening. Mathematics will be regarded as the means of interpretation. Mechanics will be finished by the end of the second year and a vast amount of time will be saved, leaving the fourth year for special courses in economics, political science and similar work designed to broaden the student's mind.

"Of course we will not do much more than begin until the war is over, but it is encouraging to be able to make a beginning. The shell is cracked off many minds here; it is going to be a fairly clean sweep and we can confidently look forward to a new kind of teaching after this.

"Studying under the S. A. T. C. arrangement will all be under supervision. Students will have no time to loaf, except on Saturday afternoon. I do not think college professors will, either. I presume there will be inspectors of the work being done.

"All of this will leave an impression on future technical education, and the graduates of engineering colleges hereafter will be better prepared to meet the world than they ever have been before. It is a pleasing prospect."

INTER NOS.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Keep Broomed Heads of Bull Points Trimmed

BROOMED heads of bull points and hand drills are almost as dangerous as shrapnel shells. Conversing recently with an engineer employed by one of the large contracting firms of the United States, he picked up a pill box which was standing on the desk, and lifted from it three jagged little fragments of steel. "Each of these steel pellets," said he, "was once a part of a broomed head of a bull point. That piece one day, under the blow of a sledge, flew off and, striking a man in the abdomen, pierced his intestines. The man died. This other piece, under the same conditions, struck a man in the cheek, went through and knocked out three teeth. That third piece cut a gash, along a man's brow and temple, which took a dozen stitches to close. Since these occurrences there has been in our work a rigid rule that every job blacksmith, as he puts an edge on a cold chisel or sharpens a bull point or hand drill, must at the same time carefully trim and square the head. We have had no further accidents from the cause mentioned." How many contractors make sure that their workmen never have to use a drill or chisel with a broomed head?

C. S. H.

Other Articles of Interest to Contractors In This Issue:

Great Submarine Chaser Factory Produces "Eagles" by Indoor Shipbuilding System Page 698

Discusses Prevention of Cracks in Hard Pavements Page 702

Concrete Barges Built True to Design Dimensions Page 704

Purdue Trains Concrete Foremen for Army Service Page 712

Compacting Concrete by Tamping Plums With Pneumatic Hammers

IN BUILDING the Copco dam on the Klamath River in northern California, concrete was placed in the foundations through shafts, some of which were 125 ft. deep. Because of the limited space in the smaller shaft sections, hand tamping was slow and ineffective, interfered with the other work, and cost about 10c. per cubic yard. The specifications were exacting in regard to well-compacted concrete, and endeavor was made to improve on tamping by hand. Pneumatic tampers were tried out, and after some attention to details the tamping cost was reduced to 5c. per cubic yard.

The smaller shafts were in sections about 16 x 50 ft. in plan, and this space was divided by the cross-bracing into 8 x 16-ft. sections. In these small sections the men shoveling concrete, placing plums and tamping were frequently in the way of one another, and when the concrete was coming at normal speed it was often extremely difficult to tamp it properly.

When tamping by hand, about 100 to 150 cu.yd. of concrete were placed per day, and six to eight men were engaged in tamping. It was found that the hand tamping accomplished very little in the way of compacting the concrete where the layers were more than 3 in. in thickness, and in no case could the concrete be compacted uniformly. When a pneumatic tamper was adapted to the work, however, it was possible for four men to tamp effectively a day's run of 300 cu.yd. or more of concrete. The pneumatic tamper could not be applied directly on the concrete itself without burying the tamping head, but by tamping the plums it was found possible to compact the concrete for a depth of 2 ft. in all directions under the plum. The principal problem connected with adapting the jackhamer used to the work of tamping the plums was to find a suitable tamper head. The first attempts were with a hemispherical piece of steel about 5 in. in diameter and ½ in. thick, whose concave side was riveted or welded to an 18-in. shank of ⅝-in. hexagonal drill steel. These tamper heads would last long enough to tamp 250 to 300 cu.yd. of concrete, after which the rivets or the weld would loosen so that the head would come off. A more successful type of tamper was built by up-setting the head of a longer piece of drill steel and working it into the shape of a cone with a base about 3 in. in diameter. This type eliminated the difficulty of the tamper head coming loose, and gave good service for 400 to 500 yd. of concrete. It has a weakness, however, in that the shank would finally

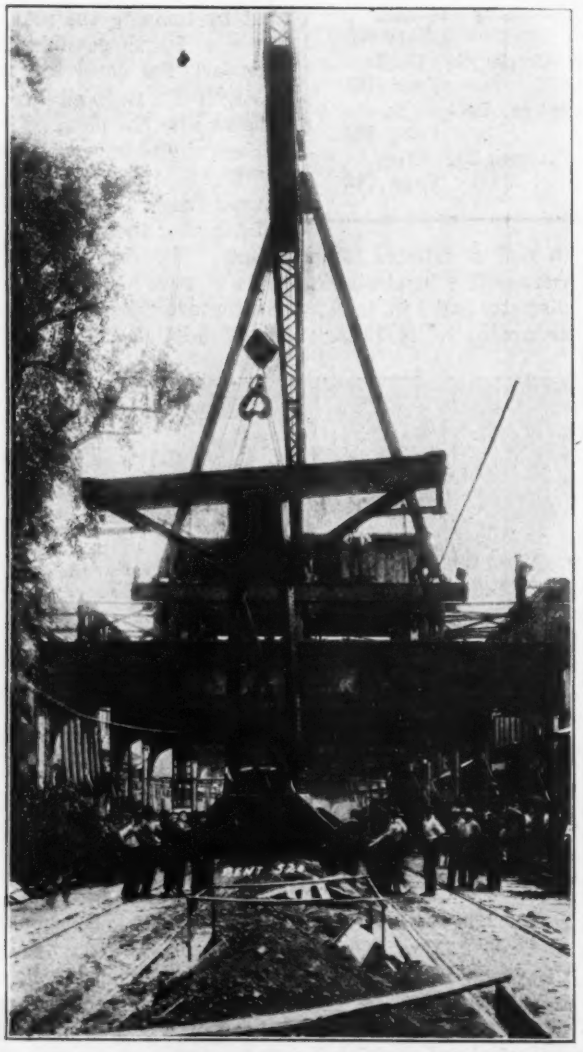
HAND TAMPING COSTS CUT IN HALF BY JACKHAMERS

crystallize and break off just where it enters the jackhamer. But with such heavy service long life for the steel was not expected, and the economies over the hand method much more than offset the maintenance costs.

The work was carried out by the California-Oregon Power Co. forces, P. O. Crawford being resident superintendent in charge of construction and installation.

Split Hose Protects Erection Men on Elevated from Trolley Wires

HOISTING steel for an elevated structure on a street occupied by trolley tracks and overhead wires has its dangers, as may be appreciated from the photograph, which shows one of McClintic-Marshall's crews setting center columns for the Frankford elevated railroad in Philadelphia. These heavy bents were raised



PROTECTION AGAINST HEAVY CURRENT BY SPLIT HOSE

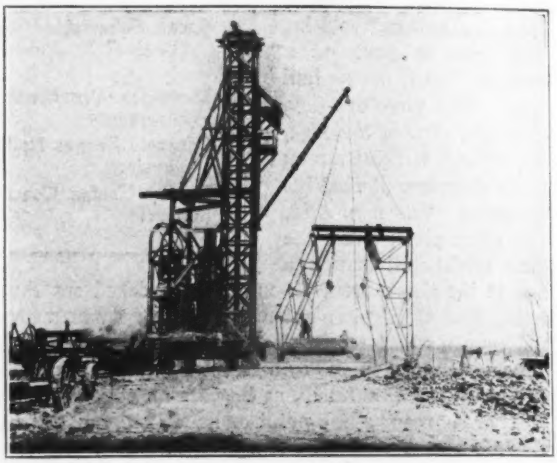
all in one piece, lowered till the base was below the car tracks, turned at right angles—bringing the base underneath the rails on either side—and lowered to place.

During these operations the trolley wires were guarded by lengths of nonconducting tubing, slit so as to be easily slipped on and moved along as the traveler progressed. The tubing can be readily seen in the photograph.

The street cars did not have to lower their trolley poles, but had to get up headway and drift the whole length of the insulation of the wire.

Boom on Traveling Tower Mixing Plant Handles Forms

WHEN not supporting chutes, the tower boom on the traveling mixer plant for the St. Paul, Minn., new high-service reservoir gave excellent service in handling forms. The view shows the mixer plant shifting the steel form carriage employed on the buttressed



WALL FORM CARRIAGE HANDLED BY TOWER BOOM ON TRAVELING MIXER PLANT

outside walls of the reservoir. The legs of this carriage straddled the wall and supported the various forms while a section was being concreted. Ordinarily the boom was occupied in supporting the swinging chute by which the concrete was delivered to the forms. Its handling of forms and its occasional use for hoisting were incidental. The contractors for the reservoir were the George J. Grant Construction Company, St. Paul, Minn.

Separating Concrete Aggregate Into Four Sizes

Concrete aggregate for use in the Lower Otay dam, now being rebuilt for the San Diego water-supply system, is being separated into four sizes, 2½, 1½, ¾ and ¼ in. This is being done so that the ideal proportioning, determined by careful tests, may be secured. The sizing is obtained without increase in cost, trials having shown that with a crusher properly set and the proper length of each mesh in the screen, the run of crusher gives the proper amount of each size. In other words, there is no wastage of material. The bins are on the side of the cañon, and the four chutes, one from each bin, are so located that they are manipulated by one man. Construction work is being carried on under the direction of H. N. Savage, consulting engineer for the city of San Diego.

NEWS OF THE WEEK

New York, October 17, 1918

Educators Organizing To Support Engineering Research Bill

A national committee of educators is being organized to support the Smith-Howard bill, now in Congress, for the establishment, in connection with state-supported universities or engineering schools, of engineering experiment stations for the promotion of engineering and industrial research. More than 35 educators, representing as many institutions, have already become members. A meeting will be held Nov. 12 in Washington for the selection of a chairman.

P. V. Stephens, consulting engineer, New York City, is the author of the bill. The bill has had one hearing before the committee on education of the House of Representatives. A second hearing is expected to be called before Nov. 1.

Canadian Contractors and Building Trades To Organize

As the result of a conference at Ottawa, Ont., in which prominent builders and contractors of Montreal, Toronto, Ottawa and London participated, it was decided to hold a convention in Ottawa Oct. 22-24, for the purpose of organizing all builders, contractors and building supply men in Canada from coast to coast, into what would be known as "The Canadian Association of Building Industries." It is understood that this move of the building interests in Canada to organize is the direct result of the changed status of the building industry, due to war conditions.

It is noted that this movement is entirely independent of any similar movement in the United States, and that it has spontaneously grown out of the pressure of abnormal conditions.

Street Flushing More Important Than Garbage Collection

Street flushing as an aid to putting down influenza in Philadelphia has been urged by physicians and others in that city. Requested to address street cleaning contractors, Dr. William Pepper, of the faculty of the University of Pennsylvania, said in part:

"Elimination of street dirt and dust is imperative, and the only way it can be done is by washing the germ-laden dust away. The more streets that are flushed, therefore, and the oftener it is done, the better conditions will become. Personally, I regard the flushing of the streets as of far more importance than the collection of garbage, for while I cannot see any great disease menace in garbage, though, of course, it is offensive, there is a very distinct menace in the dust that now blows around our streets with every wind.

"I haven't the least doubt that dust was the original disseminator of epidemic influenza in the camps and that it started in crowded barracks through the inhaling of dust carrying the contagious bacteria."

Make Nominations for Officers of American Society

The nominating committee of the American Society of Civil Engineers has presented its report to the Board of Direction, naming the following candidates for offices to be filled at the annual election Jan. 15, 1919: For president, Fayette Samuel Curtis, Boston; for vice-presidents, to serve two years, Herbert Samuel Crocker, Denver, and Leonard Metcalf, Boston; for treasurer, to serve one year, Arthur Smith Tuttle, New York City; for directors, to serve three years, George Hallett Clark, New York City; Jacob Stinman Langthorn, New York City; Charles Clement Elwell, New Haven, Conn.; Willard Beahan, Cleveland; John Watson Alvord, Chicago, and Carl Ewald Grunsky, San Francisco.

Public Health Meeting Postponed

The annual meeting of the American Public Health Association scheduled for Chicago, Oct. 14-17, has been postponed to open in Chicago Dec. 9, according to notification received from an officer of the association by *Engineering News-Record* after the issue of Oct. 10 had gone to press. This action was taken on account of the epidemic of Spanish influenza.

American Shipyards Make New Record in September

September shipbuilding figures show that the United States broke another world's record, having previously established a record in August. The completed tonnages are 369,330 dead-weight tons for September, against 339,313 tons in August. Deducting one steel ship delivered by Japan with a tonnage of 6695, the net United States tonnage is 362,635 tons. Forty-five steel ships and 29 wooden ships are included. During September the deliveries from British shipyards were 231,635 dead-weight tons, so that American shipbuilding exceeded that of Great Britain by more than 50 per cent.

All-American Canal Project Has Setback

The all-American canal project, under which the Imperial Irrigation District would build a canal wholly on American soil to connect with the La-

(Concluded on p. 734)

Another St. Lawrence River Power Addition

Canadian Government Also Protests South Sault Weir Award of Joint Commission

Following the permission to construct a weir across the South Sault channel of the St. Lawrence, the International Joint Waterways Commission has been hearing the application of the New York & Ontario Power Co. for the right to develop additional power by the construction of a dam across the Little River on the South branch of the St. Lawrence at Ogden Island. The company has now the right to develop 100,000 hp. and seeks to increase the flow of water through the power canal by 30,000 cu.ft. per sec., enabling the development of approximately 30,000 hp. additional.

The Canadian Government is opposing the company's application on the ground that (1) it will interfere with the full and economic development of the St. Lawrence system as regards navigation and power potentialities; (2) it will interfere with the complete regulation by a dam at Canada Island of the level and outflow of Lake Ontario; (3) the future development of the river will necessitate the acquisition of any rights the applicant may have in the river, and it is inadvisable to create more; (4) the St. Lawrence River has enormous potentialities, that should be developed in the most efficient and economical manner for future generations.

The Canadian Government has also made a formal diplomatic protest to the United States against the judgment of the International Joint Waterways Commission granting to the St. Lawrence Power Co. authority to dam the South Channel of the St. Lawrence River. An order-in-council has been passed outlining the contention of the Government that the commission has no power to authorize works in contravention of the Ashburton treaty and the treaty of 1909, which guarantee against interference with navigation in the boundary waters. The Canadian Government considers that if the dam that has been authorized were really needed to increase the war output of the Aluminum Co. of America, the two governments should have built it jointly, and the Dominion Government would have had no objection to a lease of the privilege of using the power thus temporarily developed. There are fears that the dam once constructed will be removed with great difficulty, if at all, and will interfere with the broad scheme of national development of the St. Lawrence as proposed.

All-American Canal Has Setback

(Concluded from p. 733)

guna dam of the Yuma project, has received a setback. The district mentioned signed a contract between itself and the Government authorizing the connection, but forwarded the contract to Washington with a protest that it was virtually acting under coercion. The district asserts that the contract would cause it to yield its priority water rights in the Colorado River to the beneficiaries of the Yuma project of the United States Reclamation Service, and that the contract would also cause surrender of certain water-power rights. Secretary of the Interior Lane has returned the contract to the district unsigned, rather than give rise to any question of coercion. The Laguna dam connection would make possible the abandonment of the Hanlon heading, and thus obviate various difficulties and dangers.

Court Confirms Commission-Manager Government for Roanoke

The commission-manager form of government for Roanoke, Va., of five commissioners and a city manager, has been confirmed by the State supreme court of appeals, which upholds the validity of the election affecting the form of city government, thereby replacing the bicameral aldermanic form of government which previously had been officially in effect.

William P. Hunter, of Doswell, Va., formerly resident engineer for the Chesapeake R.R., has been selected as city manager.

Jersey City Water-Supply Suit Passed to Highest Court

The application for a retrial of the suit in which it was decided that chlorination of the water-supply of Jersey City fulfilled the contract requirements for purity has been dismissed without prejudice by the vice-chancellor in order that it may go directly to the Court of Errors and Appeals. The basis for the application was the alleged development by experience of new evidence showing that chlorination alone does not afford the full safeguard against typhoid that was claimed for it by expert witnesses when the use of the process on a large scale was new.

Atlantic Coast Delivers First Steel Contract Ship

Delivery of the 9650-ton cargo steamship "Liberty" to the Shipping Board on Oct. 5 signalized the completion of the first Fleet Corporation contract steel ship built by any Atlantic Coast yard, and also the completion of the first fabricated ship. The keel of the vessel was laid Nov. 15, 1917.

The "Liberty" is 410 ft. long, and has a beam of 55 ft. and a molded depth of 34 ft. 11 in. The power equipment includes three Scotch boilers and geared turbines of 2500 hp. The contract speed is 11 knots, but speed of 12.8 knots was made on the trial trip.

Municipal League Will Discuss Reconstruction Problems

The National Municipal League will meet in conference at Rochester, N. Y., Nov. 20-22, to discuss American reconstruction problems. The Chamber of Commerce and the Bureau of Municipal Research of Rochester will be the hosts. The conference will open with addresses by representatives of Great Britain, France and Belgium, describing in turn what those countries are doing in the way of solving reconstruction problems.

The speakers who will treat of construction efforts among our allies are Professor Van den Ven, formerly of Louvain University, for Belgium; Thomas Adams of Ottawa and London for Great Britain, and Lieut. Maurice Boyer for France.

Notes From the Field

Observations of an Itinerant Engineer

He told me I could not leave San Diego until I had visited the Sweetwater dam and the work at the Lower Otay site. I went. But I saw more than the dams. I saw a man's man at work. I saw an organization in the forming that will render a strong account of itself.

The man began to show after we struck camp at Lower Otay the first night. Holmes was on the wire. He wanted a place as blacksmith on a job that he could stick to till it was finished—and this in a country where roving is the popular pastime. Surely, Holmes was wanted, was the reply, and for the right man there would be a bungalow for himself, the wife and children. "The more children, the better," the chief added, as he closed the deal hiring the best drill sharpener in the county. And so Holmes followed the leader to a new job.

After the "boys" had gone to their respective shacks, there was a word from the chief about each. Paddock, a born leader, he had watched carefully for some ten years, and it was he who would have charge of the masonry. Gates, under observation for as many years on different jobs, would see to the tunnel and the outlet tower, while Stebbins, who had worked for him as far back as 12 years ago, had been *commandeered* (that's exactly what was done) to save the situation—to get 30,000 yards of sand out of the reservoir bed before the rains, and bring in the cement before the roads softened. Willcomb, tried out under severe tests on other jobs, would handle designs. "A picked crew," he remarked, though even the poorest observer would have so read the competent group that a few minutes before had in brief sentences made clear the big points in the day's business.

The next morning I joined the chief at the north abutment and climbed the cañyon with him. "More good news," he beamed. "Cody, one of the best steam shovel men I know, wants to come. We surely need him to get out that sand."

At the camp we saw the showers, the excellent toilet facilities, the recreation hall, and chatted a moment with Woodman, a cook (the men assured me) who "can't be beat." "Nothing too good for men who will give good service," commented my host as I complimented his thoughtful care for his workers.

That morning, as we drove over the Sweetwater dam, I overheard his philosophy, crystallized in answering one of his men regarding an applicant, "We owe the same loyalty to a man as we expect him to give loyalty to the job."

And that's why some of the mainstays of his crew at Lower Otay have followed him half across the country. That's why mechanics and even laborers who have been on his jobs before are giving up other places to work under H. N. Savage.

* * * * * *

When Sir William Willcocks visited the Roosevelt dam he asked for a room facing and nearest the structure, that it might be first to greet his sight in the morning and be near him during the night. And when he inspected the structure he patted it caressingly, as if it might have been a thing alive. And those who saw attributed it to his warm Eastern nature, to the influence on him of the mystical atmosphere in which he had so long lived.

I was reminded of Sir William's feeling, at Sweetwater. I have had some hundreds of men show me over their work in the past dozen years, but never in the way H. N. Savage showed me over the Sweetwater dam. He had first been connected with the structure in the early nineties.

We climbed everywhere that the structure was accessible—over both abutments, into the inspection gallery, over the south spillways and then into the giant 6 x 12-ft. siphonic spillways, which are sure to stand for many a day as record hydraulic structures. At every step was detailed explanation of what was done and why. Throughout was a pride in the work that was not expressed in words, nor even in effusiveness of technical description. One felt the enthusiasm and the pride of the creator; words were unnecessary.

Curiously that attitude was reversed when we came to the south dike, an earth embankment some 45 ft. in height, concrete-faced. "This," said he, "is one of the most eminently satisfactory jobs I have ever done. It is simple, and the average man would likely pass it by. But at low cost it completely fills the purpose for which it is intended. It has won the confidence even of the farmers who lost a lot of money through the failure of this dike's predecessor."

"At low cost it completely fills the purpose for which it is intended"—there spoke the master workman. Pride unconcealed in the small job that showed forth his ideal of an engineering structure.

And as we left it, he remarked, simply, "The big structures speak for themselves."

E. J. M.

Necessity, Not Convenience, Must Govern in Utility Extensions

"Only absolute necessity must be considered, and not convenience." This, says Bernard M. Baruch, chairman of the War Industries Board, in a letter to C. S. Hamlin, chairman of the Capital Issues Committee, is what should govern in the matter of capital expenditures on public utilities—for water and gas mains, electrical trunk lines and electric railway service. The letter is the outcome of a request by Mr. Hamlin for a general rule for the guidance of utilities and utility commissions, in making applications for capital issues, and the Capital Issues Committee in passing upon such applications.

Curtail Manufacture of Road-Making Machinery

The War Industries Board announced that beginning Oct. 1 no road-making machinery should be manufactured for six months. Repair parts are expected, as are also machines to be used on various kinds of public works. The text of the order follows:

"Six months from Oct. 1 no road-making machinery or any part thereof shall be manufactured except: (1) Repair parts; (2) for work on railroads and other public utilities; (3) for roads repaired by the United States Government, the several states, counties and municipalities; (4) for new construction by the United States Government, either directly or indirectly."

$1000,000 More for Engineering Research

Ambrose Swasey, of Cleveland, Ohio, has just given Engineering Foundation an additional $100,000 for endowment of engineering research. In 1915 he gave $200,000 for this purpose, so that his total gifts are now $300,000. Mr. Swasey is a past-president of the American Society of Mechanical Engineers.

Calendar

Annual Meetings

CITY MANAGERS' ASSOCIATION; Harrison Grey Otis, Auburn, Maine, secretary-treasurer; Nov. 6-8, Roanoke, Va.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS; A. Dennis Williams, Morgantown, W. Va., acting secretary; Dec. 2-6, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS; 29 West 39th St., New York City; Dec. 3-6, New York.

AMERICAN PUBLIC HEALTH ASSOCIATION; 126 Massachusetts Ave., Boston, Dec. 9, Chicago.

The Western Society of Engineers was addressed Oct. 7 by E. T. Howson, who spoke on "The First Nine Months of Government Operation of the Railways," commenting upon the changes in railroad organization and the results of operation. While advocating Government control of the railways during the period of the war, the speaker strongly opposed Government ownership and operation as a permanent policy in this country. Phases of the contract between the railways and the Government were also discussed.

The San Francisco Sections of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, the American Institute of Electrical Engineers and the American Chemical Society held a joint meeting Sept. 26 under the auspices of the mechanical engineers' section. The subject of the meeting was "Fuel Conservation," the program including 11 speakers. This was the first meeting of the Associated Engineering Societies of San Francisco, and was attended by 325 members.

The Indiana County Commissioners held a convention in Logansport, Oct. 15-17. Road maintenance rather than new construction was emphasized in the discussion. A paper on "Seal Coats or Surface-Treated Macadam" was presented by H. M. Sharp, former state highway engineer of Ohio.

The Associated Building Contractors of Indiana is the name adopted by the organization formed at a recent meeting of building contractors at Fort Wayne, Ind., at which the following officers were elected: President, C. C. Pierson, Indianapolis; secretary-treasurer, A. H. Witte, Fort Wayne. It is planned to hold the first convention of the new organization in Indianapolis in January.

The Oregon Society of Engineers was addressed Oct. 7, by E. J. Mehren, editor of *Engineering News-Record*, on "How War Making at Washington Impresses an Engineer."

The Engineers' Club of Baltimore held a meeting Oct. 3 which was addressed by George A. Riker, district engineer, Portland Cement Association, on "Concrete Ships, Their Construction and Performance."

PERSONAL NOTES

WALTER GOODENOUGH, vice-president of the American International Shipbuilding Corporation, in charge of ship construction at Hog Island, has resigned to reënter the organization of Stone & Webster. Mr. Goodenough is succeeded by William W. Locke, formerly his assistant.

ARTHUR CRUMPTON, assistant valuation engineer of the Grand Trunk Ry., has been made valuation engineer, succeeding William McNab, who has been appointed chairman of the valuation committee. Mr. Crumpton was made assistant valuation engineer in 1916. He has been with the Grand Trunk since 1889.

LORD SHAUGHNESSY, president of the Canadian Pacific Ry., has resigned, but will remain chairman of the board of directors. E. W. Beatty, vice-president and general counsel, succeeds him.

H. L. CUNLIFF, contractor, Seattle, has closed his offices to become disbursing officer for the United States Housing Corporation at Bremerton, the Puget Sound naval station. Mr. Cunliff will reënter the building contracting field when the Bremerton housing project is completed.

CAPT. JOHN F. BLAIN, who has been in charge of steel ship construction for Emergency Fleet Corporation yards in the State of Washington, has been appointed district manager, with jurisdiction over both wood and steel construction, following the resignation of William Piggott, formerly in charge of wood construction.

JOHN L. HALL, consulting engineer, Seattle, has been appointed corporation representative for the United States Housing Corporation, Bremerton Navy Yard housing project.

W. S. SHAW, JR., has been appointed division engineer of the Michigan Central R.R., in charge of the lines in Canada, with office at St. Thomas, Ontario.

CHARLES S. CHURCHILL, assistant to the president of the Norfolk & Western Ry. under private control, has been made vice-president of the corporation. Mr. Churchill was formerly chief engineer, and has been in the service of the Norfolk & Western since 1888.

EARL MAULDIN, who for the past few years has been constructing engineer for the R. J. Reynolds Tobacco Co., Winston-Salem, N. C., has resigned to become construction engineer at Camp Bragg, the work for which is under contract by J. E. Sirrine.

CAPT. FRED E. HANSON, formerly in the valuation department of the New York, New Haven & Hartford R.R., now of the Engineer Officers' Reserve Corps, has been promoted to major and is now stationed at Camp Forrest, Georgia, as camp adjutant.

GAVIN N. HOUSTON, consulting engineer, Denver, Colo., who was in charge of the construction of the waterworks at Nitro, W. Va., has become assistant chief engineer to the commissioner of irrigation, Department of the

Interior, Canada, with headquarters at Calgary, Alberta, in work similar to that in which he was engaged between 1913 and 1916.

C. E. HAYGOOD, manager of the railway department of the Manila Electric R.R. and Light Co., Manila, P. I., is visiting the United States for the purpose of consulting with the managers of the company, the J. G. White Management Corporation, New York City. Mr. Haygood expects to return to the Philippines before the first of the year.

JULIUS L. MEIER, Portland, Ore., has been appointed regional chairman, region No. 10, highway transport committee, National Council of Defense, in charge of highway matters in Oregon, Washington and Idaho.

E. L. COLLETTE, assistant engineer of the St. Louis-San Francisco Ry. at Springfield, Mo., has been appointed district engineer at the same point. He succeeds P. J. Neff, whose appointment as engineer for the corporation was noted in these columns last week.

C. LOOMIS ALLEN has retired from the firm of Allen & Peck, Inc., engineers and managers of public utilities, Syracuse, N. Y. and Baltimore. The name of the firm has been changed to Peck-Shannahan-Cherry, Incorporated.

H. RETTINGHOUSE, chief engineer of the Chicago, St. Paul, Minneapolis & Omaha Ry., has received jurisdiction over the St. Paul Union Depot.

GEORGE HUTCHINSON, superintendent of construction of the Chickasaw Shipbuilding Co., Mobile, Ala., has been promoted to assistant general superintendent.

A. D. BUTLER, city engineer of Spokane, Wash., has been granted leave of absence to enter the service of the War Department at Washington as a civilian engineer. It is expected that Mr. Butler will be commissioned later, probably for duty overseas.

CHARLES F. LOSH has been appointed valuation engineer of the Norfolk & Western Railway.

N. W. DOWNS, assistant chief engineer, Board of Education, Kansas City, Mo., has received leave of absence to enter Government service in construction work, with headquarters in Washington, D. C.

W. J. BERGEN, first assistant to the chief engineer of the New York, Chicago & St. Louis R.R., has been appointed chief engineer of the corporation, with headquarters at Cleveland. Mr. Bergen was born in 1872 and was graduated from Rensselaer Polytechnic Institute in 1897. From 1899 to 1901 he was with the Burlington & Missouri River Ry., most of the time as division engineer on construction. In 1901 he went to the New York, Chicago & St. Louis R.R., as assistant engineer. In 1907 he was made chief supervisor of track, and later in the same year he was promoted to first assistant to the chief engineer.

J. W. REID, bridge engineer of the Chicago & Alton R.R., has resigned to enter the service of the Robins Conveying Belt Co., Chicago.

VIRGIL LEE, formerly of the county surveyor's office, Madison County, Indiana, has been appointed city engineer of Anderson, Ind.

HARRY C. LEA, formerly director of public works, Aspinwall, Penn., is now connected with the United States Ordnance Department, Pittsburgh district.

J. E. JOHNSON, division engineer of the Michigan Central R.R., at St. Thomas, Ontario, has resigned in order to enter private business.

G. W. SMITH, assistant chief engineer, Nash Motors Co., Kenosha, Wis., is now chief inspector of the motors division, Quartermaster Corps, U. S. A., with headquarters at Detroit.

J. R. CASWELL has been appointed division engineer of the Canadian Pacific Ry. at London, Ont.

OBITUARY

CAPT. KIRBY BALDWIN SLEPPY, Corps of Engineers, formerly an engineer on the Los Angeles aqueduct, has been killed in action in France. Captain Sleppy entered the officers' training camp at the Presidio, San Francisco, a month after the United States declared war. He joined the Engineer Corps of California, a volunteer organization, in 1917, and was a member of the Military Engineers' Association of Los Angeles. He went to the training camp at the Presidio as a first lieutenant and was graduated as a captain. He had been in France about seven months. Before going to Los Angeles, he was engineer for the Southern Sierras Power Co. Captain Sleppy was a graduate of the University of Pennsylvania.

LIEUT. ARTHUR K. ATKIN, who was an engineer with offices at 87 Wall St., New York City, at the time war was declared, has died of wounds. Lieutenant Atkin was a graduate of the Plattsburg officers' training camp, and for several months afterward was stationed on Governors Island. He went overseas in Company L, 165th Infantry, "Rainbow" Division. On his arrival in France he was transferred to the 126th Infantry. He was a graduate of the Massachusetts Institute of Technology.

LIEUT. FRANK DICKIE, of Indianapolis, Ind., who was with the engineers at Chateau Thierry and was afterward ordered home for instruction duty, died of pneumonia on Oct. 3 at Camp A. A. Humphreys, Virginia. He was 26 years old and became an officer after attendance at the officers' training camp at Fort Sheridan, Illinois. He had been in France for five months.

RAYMOND R. HILL, construction engineer, Arnold Co., Chicago, died Oct. 5 while engaged on war work at Schenectady, N. Y. He was 41 years old. From 1905 to 1910 he was superintendent of bridges and buildings for the Metropolitan Street Railway Co., Kansas City, Mo., leaving this position to superintend the construction of the Dallas-Oak Cliff Viaduct. In 1912 he rebuilt the Kaw River Bridge at Kansas City, for the Missouri Pacific R.R., and the following year had charge of construction of deep river piers for a bridge over the St. Francis River at Riversville, Que. Later he installed a water-works intake for Hamilton, Ont., and also an intake pipe for the National Steel Car Co., into Hamilton Bay. Mr. Hill's most recent work was in the reconstruction of the Pullman shops at Pullman, Ill., for the Arnold Company.

CAPT. N. SIMONSON, president, and Perry A. Clapper, secretary and treasurer of the American Construction Co., lost their lives as the result of an automobile accident, while returning from a business trip Sept. 26. Mr. Clapper's death occurred the day after the accident and Captain Simonson died Oct. 3.

CHARLES A. MILLER, city engineer of Oregon City, Ore., died recently at his home in that city. Mr. Miller became city engineer of Oregon City in 1915; before that time he was connected with the Portland-Eugene & Eastern Ry. He had been associated with railroad engineering work in the Northwest for a number of years, and was engaged in the construction of the Tacoma street railways and the Willamette Falls Ry., being superintendent of the latter for 22 years.

H. W. BELNAP, chief of the bureau of safety of the Interstate Commerce Commission, died Oct. 12 in Washington.

WALLACE B. LINDSAY, head of the electrical engineering department of Ingersoll-Rand & Co., died of pneumonia at his home in New York City Oct. 10.

NEWS OF ENGINEERING INDUSTRIES

FOR MANUFACTURERS WHO SERVE ENGINEERS AND CONTRACTORS

American Potash Challenges German Competition

Recovery as Byproduct from Cement and Iron Plants Will Give Large Tonnage and Revenue

That the cement industry of the United States alone is capable of producing from 80,000 to 100,000 tons of potash annually is indicated by data and estimates furnished in a report by the bureau of soils, Department of Agriculture. It is also possible for a 3,000-bbl. cement plant to realize a profit of almost $500,000 annually in the recovery of potash from waste gases. Similar indications come from investigations made in blast furnaces.

GERMAN RESOURCES

Germany's immense deposits, the potash content of some of which run as high as 16%, the predatory actions by its government and industrial financiers, together with subsidies and other efforts to control the industry in the years preceding the war, reduced the whole world to almost an economic dependency on Germany for this important product. Basing her belief on the immense supply she has, and her ability to produce it at less cost than others, and on the idea that the other countries of the world will not be able to produce potash in sufficient quantities for their home demand so that of necessity she will be able to enter those markets, she hopes to be able to regain her place in commerce after the war. The Stassfurt mines in Germany are easily able to produce sufficient potash to supply the needs of the whole world, and the extent to which she dominated the world's markets prior to the war is illustrated by the British supply in 1913. The total imports were valued at approximately $6,500,000, of which almost $4,500,000, or 66%, was imported from Germany. The nearest competitor was France, with somewhat more than $900,000, or about 14%.

The chief demand for the material arises in the need for potash fertilizer in agriculture and in the manufacture of explosives. The lead held by Germany in the manufacture of optical goods is also due to the highly developed potash industry of that country. These industries, as well as the dye industries, have been developed in this country and Great Britain since the outbreak of the war, and the strides made in these respects will in themselves be the source of a considerable demand, to which the cement industries and the blast furnaces will look for the consumption of their byproducts.

The acute shortage experienced in Great Britain at the outbreak of the war led that country to study the problem immediately, and it was found that by the addition of small proportions of common salt, involving but a slight increase in cost, into the blast furnace workings made the potash present in the ore obtainable from the emerging gases as potassium chloride without injury to the pig iron product. It was found that the British furnaces were capable of producing 50,000 tons of potash salt per annum, or enough to supply practically the entire needs of the country.

The recovery of potash as a byproduct from cement mills in the United States was studied and developed first at the Riverside Portland Cement Co.'s plant in California. A process was installed to abate the dust nuisance, the varying fineness of the precipitates of which led to the study of the composition of the dust and to the discovery of the high alkaline content. The first study and development of the process of recovering the potash from blast furnace gases was made in eastern Pennsylvania, particularly at the South Bethlehem plant of the Bethlehem Steel Company.

AN ECONOMIC WEAPON

Interest in the various processes will increase, it is believed, as the country realizes the economic weapon available against Germany and her highly organized industry. England and France are alive to the situation and are developing their resources to the utmost. The prospects for the byproduct industry are largest in the South, where the iron ore and other raw materials lend themselves to the possibility of a large output, and the demand for potash fertilizer in the cotton fields in the neighborhood makes a market close at hand. The high development of byproducts in other industries, and the advantages those industries have reaped from them, the value of this byproduct in stabilizing the industry from which it is derived, as by enabling iron furnaces to stay in blast at a time when the main demand is low, give the new industry a large economic value, according to authorities who are studying the problem.

Texas Company Rearranges Its Organization

Announcement was made, effective Oct. 1, that that part of the Texas Co.'s asphalt and road-oil business heretofore conducted in the name of its special agent, John Baker, Jr., will in the future be conducted in the name of the Texas Co. asphalt department. Present offices and organization of the John Baker, Jr. Co., will be retained.

Alien Property Custodian Urges Closer Coöperation

Coöperation in the work of uncovering money and property of enemy character, by readers of *Engineering News-Record*, is urged by A. Mitchell Palmer, United States alien property custodian. He requests that any information regarding the enemy interests in any activity be forwarded immediately to Francis P. Garvan, director of the bureau of investigation, Alien Property Custodian Office, Washington, D. C. Mr. Palmer asks that even if the information is only rumor it should be reported. Clews to many important enemy interests have been obtained in this way. The money realized from the sale of enemy property is invested in Liberty Bonds, and is made to fight for our country, instead of against it. The trading with the enemy act requires the reporting of property rights and claims of every kind, tangible and intangible, bonds, notes, money, securities, lands, indebtedness, and accounts receivable.

Manufacturers as Special Assistants to Chief of Ordnance

The War Department has appointed two prominent manufacturers as special assistants to the Chief of Ordnance. They are W. W. Coleman, president of the, Bucyrus Co., South Milwaukee, Wis., one of the largest producers of steam shovels and dredges, and T. H. Symington, a member of the firm of Symington-Anderson Co., Rochester, N. Y., iron and steel manufacturers.

Mr. Coleman will have charge of all matters connected with the production of cannon carriages, their appurtenances and accessories, and will follow the production of these munitions through the stages of design, production and supply. Mr. Symington will have similar charge of artillery ammunition metal parts, etc.

Epidemic Causes Postponement of War Conference

Notice has been received from the American Supply and Machinery Manufacturers' Association that its proposed war service conference, which was to have been held at Atlantic City Oct. 22 must be indefinitely postponed on account of the prevalence of influenza in New Jersey and at Atlantic City. Owing to the gravity of the situation, the health authorities of the state and city felt that it was impossible to grant permission to hold the conference, and the association announces that the various members will be advised later as to plans to prevent the slowing up of war activities by this decision.

Recover Army Supplies Worth $10,000,000

Searches by Division of Military Aeronautics Disclose Large Stores Apparently Lost

The Division of Military Aëronautics has turned up since Aug. 6 a surplus of supplies worth $10,000,000 which was apparently lost, and its examiners have not yet finished their task. The supplies already listed include typewriters, motor cars, motor trucks, oil, lumber, wood, iron and steel-working machines, motorcycles, building materials, airplanes, and about everything in the accessory line, from screw eyes to stove bolts.

The division of the General Staff which is carrying on this investigation and has accomplished this task is known as the surplus inactive supply service, purchase and storage branch, purchase, storage and traffic division of the General Staff. It has branches in most of the bureaus of the War Department, and the object of their work is to utilize duplicate supplies purchased through the unavoidable lack of organization in the emergency and rush at the beginning of the war. These surplus supplies, as fast as they are found, are listed, and through a system of trade, transfer and sale, either put to use in the department or sold in the public market. The Division of Military Aëronautics has already turned over to the Surplus Inactive Supply Service property amounting to more than $2,000,000, which none of its own branches could use.

CONSTRUCTION MATERIAL FOUND

Among the material found and immediately put to use was 4,500,000 feet of ⅛-in. rope. The present demand for rope is exceedingly great, and specifications were changed in order to take advantage of this "find." Another consignment that was found and immediately put to use was 500 pairs of field glasses, worth $37,500. These were found in a supply depot at Omaha, and other emergency supplies to the value of $75,000 were discovered in this same station and immediately shipped overseas. Other surplus supplies found included seven carloads of iron, steel and woodworking machinery found in a supply depot at Hampton, Va. In one of these cars was a wire-testing machine badly needed in France. Five thousand steel drums also wanted for oil containers were discovered in a private storage; although they were not the property of the Government they were put into immediate use and the owner was paid for them.

Pulverized Fuel Mixer Operates Under 6-Ounce Pressure

The feeding mixer for pulverized coal illustrated and described on p. 693 of the last issue of *Engineering News-Record* operates under 6-oz. pressure and not under 6-lb. pressure as noted.

Auto Manufacturers Approaching 100% War Basis

That the automobile manufacturers of the United States are rapidly reaching a 100% war basis, as suggested by the War Industries Board recently, is indicated in reports made to the National Automobile Chamber of Commerce at a recent meeting. The report also showed that contracts for Government war work aggregating $800,000,000 have been taken by the motor-car factories.

C. C. Hanch, chief of the automotive products section of the War Industries Board, explained the new priority ruling that will govern the production of automobiles and automobile trucks. The production of trucks has been limited to one-third of the average for the 18 months which ended July 1 last, with the understanding that no trucks are to be sold except to absolutely essential industries.

The general war condition of the industry, the need for good roads to expedite transportation, and the growth of the rural motor express, were also discussed.

Mobile Crane on Electric Tractor Operated by Same Battery

A tractor equipped with a two-ton capacity crane, also operated by electric motors, and supplied with current from the storage battery used to propel the electric vehicle, has recently appeared in response to a demand from terminal and manufacturing plants. War conditions in such plants created the necessity for a more flexible plant of this nature, although to gain this flexibility a certain amount of lifting capacity had to be sacrificed.

Recently, however, one of these electric crane tractors unloaded a freight of large crates of army kitchen equipment weighing approximately 3700 lb. After lifting the cases off the freight car it backed away, and, running across the pier under its own power, deposited the load.

The boom of the crane swings 180 deg. so that after material is lifted it can be deposited easily on the ground or on a trailer for transportation elsewhere. The tractor also being equipped with a spring draw-bar coupler at the rear of the frame, it is therefore possible to load trailers by means of the electric crane and then haul these trailers electrically to another point and unload them.

Locomotive or overhead cranes are not always available at just the place where it is necessary to handle material at a given time, and, even if available, they cannot always be transported quickly from one point to another as can a crane tractor of this type. It is manufactured by the Walker Vehicle Co., New York City.

BUSINESS NOTES

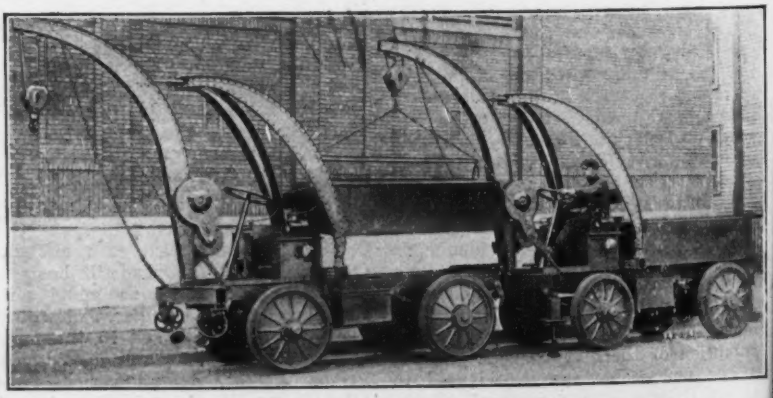
The Electro Bleaching Gas Co., 18 East 41st St., New York, has discontinued its Chicago office on account of war demands on its force. G. R. Ellis, in charge of the Chicago office, has been transferred to the plant at Niagara Falls, and placed in charge of the office.

The pipe order from the United States to the Continental Pipe and Mfg. Co. involving 230,000 ft. of wood-stave pipe, varies from 6 in. to 18 in. instead of from 6 in. to 8 in., as noted in *Engineering News-Record* of Sept. 26, p. 606.

TRADE PUBLICATIONS

The United Iron Works, Kansas City, Mo., has published catalog P-18 illustrated with line cuts and halftones of different models of pumping machines, and a short description of the application and uses of each model.

The Austin Co., industrial engineers and builders, Cleveland, Ohio, has issued a 63-p. book entitled "Austin Standard Factory Buildings." It explains the Austin method of factory construction, and includes engineering data, illustrations and descriptions of the 10 types of Austin standard factory building.



ELECTRIC TRACTOR AND CRANE IN OPERATION